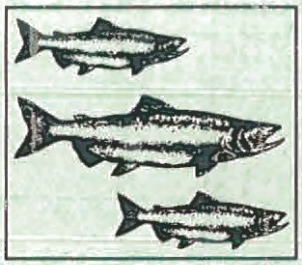

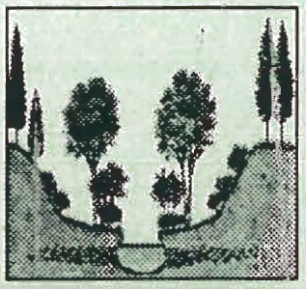

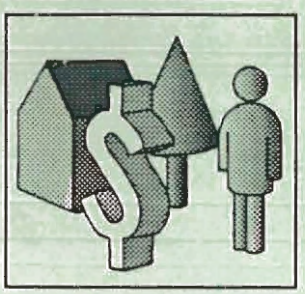

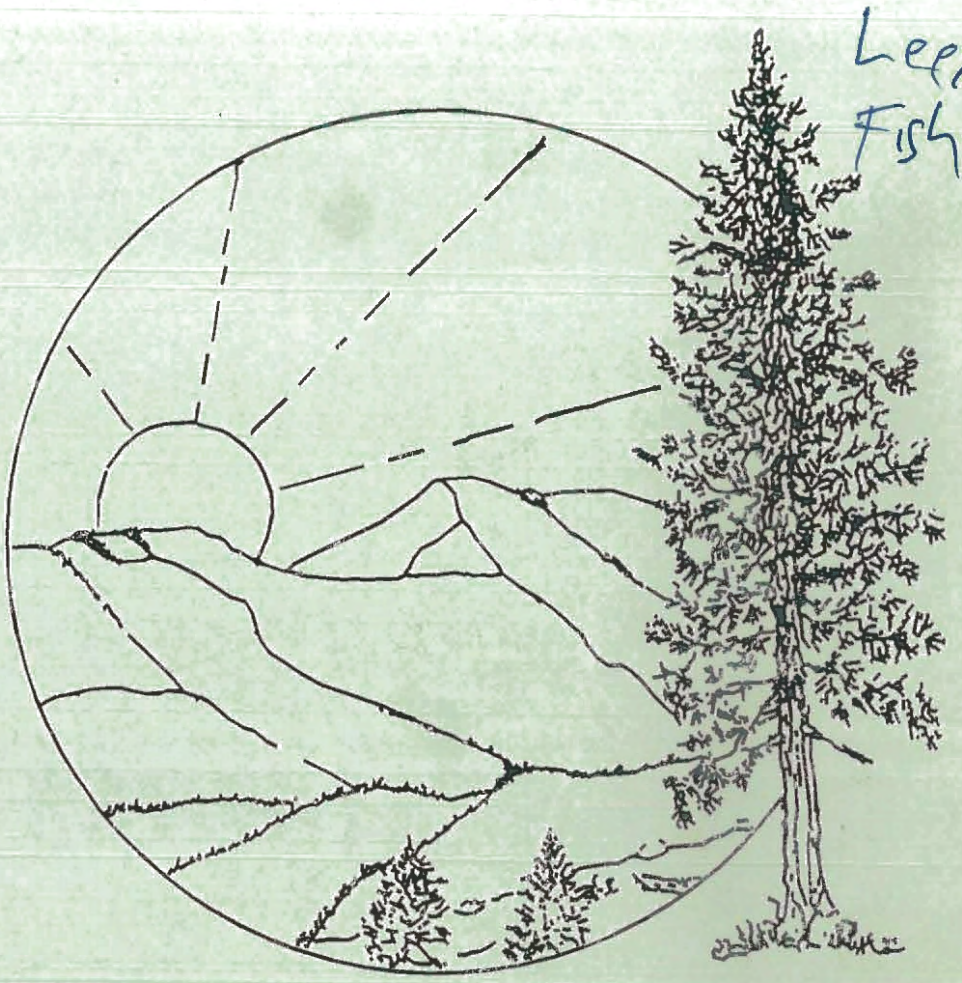

Lee/
Fish

United States
Department of Agriculture
Forest Service

United States
Department of the Interior
Bureau of Land Management

Watershed Analysis Report for the Upper Main Eel River Watershed

May 1995

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1.0 DESCRIPTION OF THE UPPER MAIN EEL WATERSHED

1.1 Location and Geography

The majority for the Upper Main Eel watershed lies within the Mendocino National Forest (the Forest), which is located on the west side of the California Coast Range approximately 25 miles northeast of Ukiah, California (Figure 1-1). Most of the watershed (84 percent) lies in Lake County, California. The remainder is in Mendocino County (10 percent) and Glenn County (6 percent) (Figure 1-2). The watershed includes the headwaters of the Eel River downstream to the Cape Horn Dam.

The eastern boundary of the watershed runs along the backbone of the California Coast Range from Bald Mountain (6,739 feet) in the north, through Snow Mountain (at 7,038 feet, the highest point in the watershed), to Goat Mountain (6,121 feet) in the south. It forms a basin of nearly 350 square miles encompassing the entire Eel River drainage above Cape Horn Dam. Cape Horn Dam (which impounds the Van Arsdale Reservoir) is located at the low point of the watershed with a spillway elevation of 1,493 ft.

Above Cape Horn Dam on the Eel River, near the center of the watershed, lies another reservoir, Lake Pillsbury, which is impounded by Scott Dam (Spillway elevation 1818 ft.) Lake Pillsbury has three main arms: the Eel River Valley and Canyon forms the eastern arm, the Rice Fork Canyon forms the deep, narrow southern arm, and Smokehouse Creek and other streams feed the broad, but shallow northern arm which inundates the lower part of Gravelly Valley. Almost 80 percent of the watershed analysis area drains into Lake Pillsbury with the remainder draining into the Eel River below Scott Dam. When full, the lake covers over 3 square miles.

1.2 Climate

The climate of the Upper Main Eel watershed is relatively moderate with occasional extreme temperatures during the winter and summer. During the summer, temperatures often exceed 100 degrees, while winter temperatures usually fall below freezing. Over 80 percent of the seasonal rainfall occurs between November 1 and April 1. Rainfall at the upper elevations is relatively high, averaging 50-60 inches per year along the eastern boundary of the watershed, and 70-80 inches per year around Bald Mountain. In the valleys, rainfall averages 40-50 inches per year, with the lowest amounts in the vicinity of Lake Pillsbury. Snow occasionally falls at the 2,500-foot level, but seldom builds any significant snowpack below 5,000 feet.

A U.S. Weather Bureau continuous-record precipitation station was operated near Lake Pillsbury from 1907 to 1936. During this 29-year period, the mean annual precipitation was 47.62 inches and the monthly precipitation ranged from 0 to 18.10 inches. The temperature range during the same period was from 15 degrees to 107 degrees F. At the present time the U.S. Weather Bureau precipitation station nearest the Upper Main Eel drainage is located at the Potter Valley powerhouse 10 miles southwest of Scott Dam at an elevation of 1,014 feet above mean sea level. The mean annual precipitation at the Potter Valley location, based on a 48-year period record through 1959, is 43.70 inches.

1.3 Geology and Soils

As with much of the rest of the Coast Range Mountains, the topography of deep gorges and limited bottom flatlands attest to the geological youth of the Upper Main Eel watershed. The present landscape has been uplifted by a series of orogenies (mountain-forming events). The latest uplift began in the Pleistocene (about 3 million years ago), and is still progressing, as indicated by the deep (over 800 feet) inner gorge that the Eel River has cut into bedrock.

Figure 1-1. Mendocino National Forest location map.

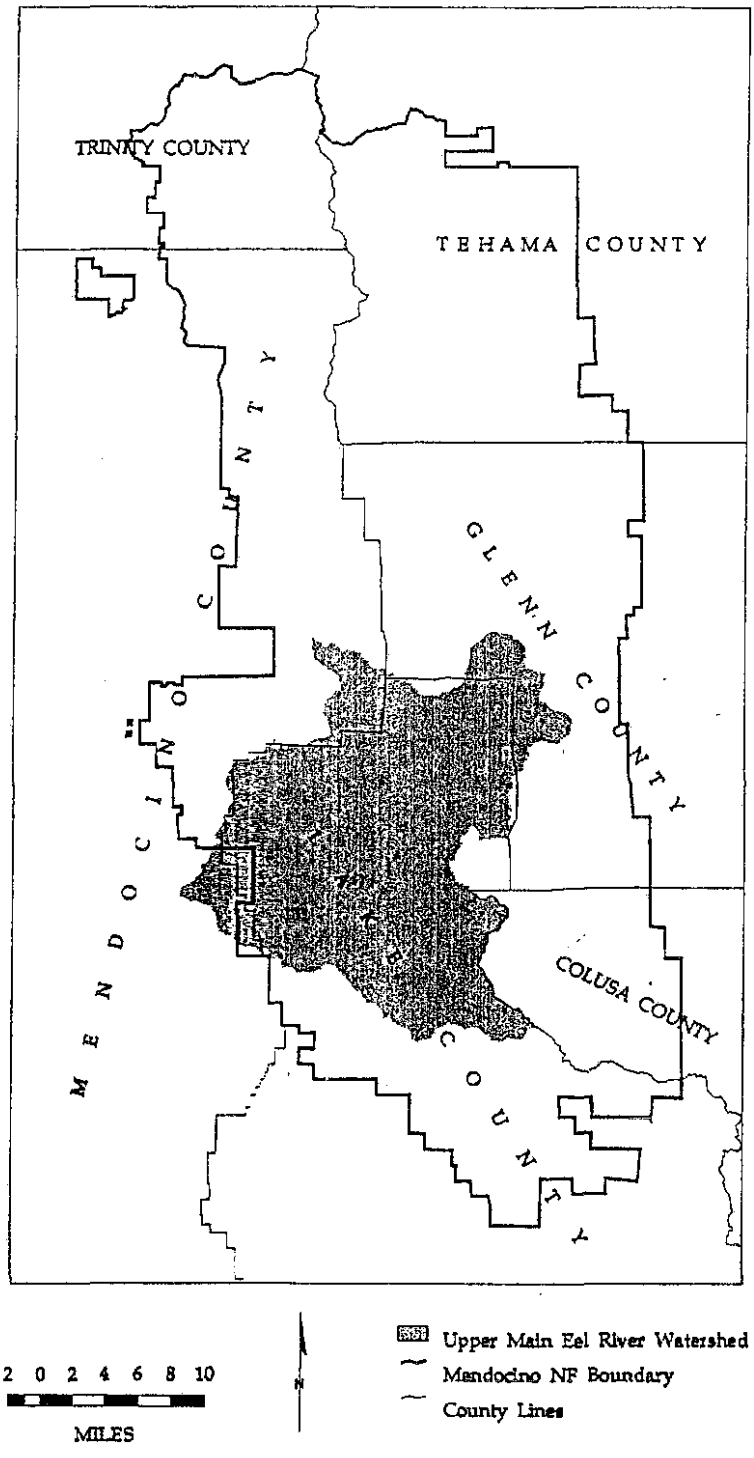

Figure 1-2. Upper Main Eel watershed location map.

The Bartlett Springs Fault Zone crosses the watershed in a southeast to northwest direction. The Rice Fork Valley and the down-dropped block forming Gravelly Valley are features of this fault zone. Lake Pillsbury fills a portion of Gravelly Valley. Rapid uplift on the northeast and southwest sides of the fault zone has caused the formation of deep penetrating bedrock fractures and joints. A set of pressure release fractures have formed which are sub-parallel to the surface. These planes of weakness along with faults allow the deep penetration of water into certain areas of the bedrock, locations of weathering and slide movement.

The watershed is underlain by rock formations of late Jurassic to Eocene age (120-55 million years before present). Sedimentary and metamorphic rocks are found along with ultramafic and volcanic rocks of Jurassic age. With weathering, much of the bedrock will produce unstable soils which are subject to landslides, slumps, and erosion. Landslides and soil creep are common within the watershed.

1.4 Hydrology

Plate 1 shows the major streams in the Upper Main Eel watershed. The California State Water Resources Control Board name for this watershed is the Lake Pillsbury Hydrologic Subarea (CALWATER Basin No. 11163). It is part of the Eel River Hydrologic Area of the California North Coast Hydrologic Unit.

The Eel River begins in a high basin on the slopes of Bald Mountain. It flows southeast and then south for 23 miles, gaining additional water from Hull Creek, Corbin Creek, Cold Creek, and other tributaries before turning westward to flow through a narrow canyon into Lake Pillsbury. In this distance the river drops from 6,200 feet to 1,800 feet elevation. In one section near its headwaters, the Eel drops over 1,000 feet in .75 miles and continues to drop an additional 1,000 feet in the next 2 miles. The tributaries also have steep channels.

Rice Fork rises on the west side of Goat Mountain, and flows north 15.5 miles along the Bartlett Springs Fault Zone into Lake Pillsbury. In this distance it drops from 5,600 feet to 1,800 feet. Rice Fork at many locations flows in a narrow canyon that is often 1,000 feet deep. The narrow canyon is caused by the river eroding weak rocks within the fault zone.

Several streams between Boardman Ridge and Ericson Ridge drain into Gravelly Valley. Water from these streams then follows faults that offset alluvium on the flat valley floor. During the rainy season these streams flow into Lake Pillsbury, but during the dry season, water in these streams soaks into the alluvium, and there is no surface flow into the lake.

The flow of the Eel River, Rice Fork, and other streams above Lake Pillsbury is unregulated, and primarily influenced by rainstorms. Snow melt runoff is minor, and occurs mainly during April and May. The area's mild, wet winters and hot, dry summers lead to large seasonal stream flow changes. The summer flows often drop to very low values above Lake Pillsbury. Winter high flows often exceed five thousand cubic feet per second below Scott Dam. Turbidity is a problem during peak flows. The greatest danger for flooding occurs when warm rains fall on the snowpack, causing release of all the water in a short period of time. This was the cause of the two most recent great floods which occurred in 1955 and 1964.

After leaving Lake Pillsbury, the Eel River flows through a narrow canyon cut into the uplifting basement. Twelve miles below Lake Pillsbury, a significant portion of the river's flow is diverted from Van Arsdale reservoir through a tunnel to a Pacific Gas and Electric Company powerhouse located in Potter Valley, from which it flows to the ocean via the East Fork of the Russian River. The diverted water is also used for urban, agricultural and recreational purposes in the Russian River basin. The Eel River below Cape Horn Dam is a National Wild and Scenic River which flows in a northwesterly direction approximately 112 air miles to empty into the Pacific Ocean south of Humboldt Bay.

1.5 Fisheries

Fishery resources include Lake Pillsbury and about 150 stream miles in the Upper Main Eel River and its tributaries (Plate 4). Historic runs of salmon and steelhead above the lake were eliminated when Lake Pillsbury was created. Salmon and steelhead are still found in about 26 miles of habitat downstream of Lake Pillsbury.

1.6 Plant Communities

A great variety of vegetation exists in the Upper Main Eel River. Plant associations range from oak woodlands with blue oak (*Quercus douglasii*) and a grass understory in the lower elevations of the watershed, to red fir (*Abies magnifica*) at the higher elevations. Lower slopes and south aspect forests are dominated by chaparral vegetation including manzanita (*Arctostaphylos* spp.), *Ceanothus* (various spp.), and chamise (*Adenostoma fasciculatum*) and various species of oak (*Quercus*, spp.). Ridgetops, upper slopes and north aspects generally support coniferous forests of various species mixtures. The areas with shallow soils or harsher aspects (south and southwest) have ponderosa pine (*Pinus ponderosa*) forests with small components of other tree species and grass and brush understory. Where more favorable soil moisture conditions exist, or on higher elevations and north aspects, mixed conifer forests grow. Species present in these forests vary with site and include sugar pine (*Pinus lambertiana*), incense-cedar (*Calocedrus decurrens*), Douglas-fir (*Pseudotsuga menzesii*), ponderosa pine, and white fir (*Abies concolor*). Hardwood trees, including black oak (*Quercus kelloggi*), live oak (*Q. wislizenii* and *Q. chrysolepsis*) and madrone (*Arbutus menzesii*), compose a significant minority in some of the mixed conifer forests. The highest elevation forested areas are occupied by red fir forests. Smaller areas of the landscape are occupied by grasses (in both dry glades and wet meadows) and pure hardwood forests. Significant areas of the watershed are occupied by disturbance-dependant vegetation types such as knobcone pine (*Pinus attenuata*).

Several sensitive plant species occur within the Upper Main Eel watershed. These plants include: scabrid raillardella (*Raillardiopsis scabrida*), Anthony Peak lupine (*Lupinus antoninus*), Stebbins' lewisia (*Lewisia stebbinsii*), Cleveland's milk vetch (*Astragalus clevelandii*), glandular dwarf flax (*Hesperolinon adenophyllum*), drymaria-like dwarf flax (*Hesperolinon drymarioides*), and Snow Mountain willowherb (*Epilobium nivium*). Snow Mountain buckwheat (*Erigonum nervulosum*) is found immediately adjacent to the watershed in the Snow Mountain area.

1.7 Fire

Fire has been a major force in the formation of western ecosystems, including the Upper Main Eel watershed. The Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (FSEIS) (USDA FS and USDI BLM 1994a) recognized that fire has played "...a major role in shaping the forests of this province" with reference to the California Klamath Physiographic Province (which includes the Upper Main Eel watershed). Typical fire-return intervals and fire severities have been found to be highly variable, and wildfires did not always result in complete stand mortality. Small local studies have indicated fire return intervals in the 12- to 30-year range. This would indicate that prior to fire suppression efforts, a fire regime existed that was typified by fires that were both more frequent and less intense.

Humans, to varying extents, have influenced fire frequencies and intensities. The earliest period of human occupation in the North Coast Ranges was perhaps 8,000 years before the present time (B.P.). By about 3,000 B.P., human-caused fires were quite likely a major force influencing vegetation successional trajectories and environmental dynamics in this region (Keter 1994). The American Indian and rancher/settler influence on the vegetation of the Upper Main Eel area declined after the establishment of the National Forests in the early 1900s.

1.8 Wildlife

There are many different wildlife habitat zones identified within the Upper Main Eel watershed. These include the pine-fir-chaparral, woodland-chaparral, chaparral, hardwood, conifer-hardwood, conifer, riparian, barren, woodland-grass, valley-urban interface and agricultural zones. In certain cases, zones overlap or are in transition due to wildland fires, urban growth, and logging.

Due to the highly variable nature of vegetation types found within the watershed, wildlife habitat is greatly influenced by edge effect. Edge effect is important when assessing wildlife habitat quality in this watershed. An edge is the place where plant communities meet, or where successional stages or vegetative conditions within plant communities come together. The area influenced by the transition between communities or stages is called an ecotone. Edges and their ecotones are usually richer in wildlife than the adjoining plant communities or successional stages (Thomas 1979). Due to the variety of habitats and successional stages within the watershed, the area has a variety of bird and mammal species. These species include but are not limited to bald eagles, peregrine falcons, northern spotted owl, marten, fisher, pileated woodpecker, flying squirrel, grey squirrel, grouse, quail, neotropical migratory birds, black-bears, mountain lions, coyotes, grey fox, black-tail deer, northern flicker, band-tail pigeons, and deer mice.

1.9 Historical Context

There is evidence of prehistoric use of the watershed, particularly in the higher elevations, during the Lower Archaic period (circa 8000-5000 B.P.). However, the nature of this use, whether for seasonal habitation or resource procurement, is poorly understood. Seasonal occupation within the locality, especially in the lowlands (e.g., Gravelly Valley), probably occurred during the subsequent Middle Archaic period (circa 5000-3000 B.P.). By the end of the Upper Archaic period (circa 3000-1500 B.P.), more permanent occupation of the lowlands and periodic settlement and use of the uplands had probably occurred. Permanent occupation along primary rivers and seasonal occupation and use of the entire watershed was more widespread by 1500-200 B.P.

The study area was occupied at historic contact (circa 1850) by three distinct American Indian groups: Yuki, Huchnom, and Pomo. Small portions of Northern Pomo and Eastern Pomo territories appear to have included some of the southern fringes of the watershed, but precise boundaries are problematic. The majority of the region was occupied by the Onkolukomno'm Yuki, the southernmost subdivision of the Yuki (Foster 1944). The eastern boundary of the Onkolukomno'm Yuki roughly parallels that of the watershed's study area on the east and the north (Barrett 1908, Miller 1978). Huchnom territory was centered on the Main Eel River, on the east from its confluence with the Rice Fork in Gravelly Valley west to a point north of the confluence of Outlet Creek. The Sanhedrin Mountain crest formed the boundary to the north and their southern boundary ran between Horse Mountain and through the uplands north of Potter Valley (Barrett 1908). The Huchnom spoke a dialect of the Yukian language, but culturally were more diverse, adopting both Yuki and Pomo cultural traits (Foster 1944).

Huchnom residential villages were located along the Main Eel River and on some of its major tributaries. Temporary residential sites and locations where specific resources were procured were situated along seasonal tributaries near localized, resource rich areas often near meadows and springs in the uplands. Of the 13 ethnographic Huchnom residential villages described by Barrett (1908), 11 are located on the Main Eel River and 2 are on Tomki Creek. According to Barrett (1908), only three of these ethnographic villages are located within the watershed study area: (1) *li'lkool* or *kalu'yakai* (Northern Pomo dialect names) was situated in the vicinity of Cape Horn Dam; (2) *komohmemutkuyu'k* or *co'nba* (Northern Pomo dialect names) was located on the Main Eel River west of the Mendocino National Forest boundary; and (3) *mumeme't* was located on the Main Eel River downstream from its confluence with Salmon Creek in Gravelly Valley. Barrett (1908) also lists some Northeastern Pomo names for Yuki villages in Gravelly Valley: (1) *hunkali't* was located

on the north bank of the Main Eel River, a short distance southeast of Hullville in Gravelly Valley; and (2) *uwului'me* was located a short distance southwest of Hullville in Gravelly Valley on the Main Eel River.

Gravelly Valley was known to the Yuki as *nutc-ukom* (gravel valley) and to the Eastern Pomo as *kutas'ku-kai* (starvation valley) (Barrett 1908). The absence of more detailed ethnohistoric period information about Gravelly Valley is probably the result of two factors: its distance from principal Yuki occupation areas, and disruption caused by early contact with white settlers. Onkolukomno'm, which roughly translates to "land on the other side" (Barrett 1908) or "ground in another valley people" (Foster 1944), suggests that this subgroup was geographically more isolated than the remainder of the Yuki.

Historic use of the watershed study area appears to have occurred at least by the mid-1850s, but initial settlement may not have begun until the early 1860s. James Hull, a resident of the Sacramento Valley, established a hunting cabin in 1856 on a prominent mountain (now Hull Mountain) north of Gravelly Valley, but was killed by a grizzly bear while hunting deer that same year. Troubles between white settlers and Indians began with the arrival of the "foreigners" but had tapered off by the late 1860s. Market hunters killed by Indians in a log cabin in Gravelly Valley, probably in the early 1860s, may have been among some of the earliest settlers in the valley (Mauldin 1967). One particular event that probably occurred in the early 1860s illustrates the impact that the conflict between whites and Indians had on the Yuki in this area. White settlers cornered 30-60 Indians at Bloody Rock on the Main Eel River; after some of the Indians were killed, the remaining jumped to their deaths rather than be captured.

In 1867, George and Cy McMath bought property in Gravelly Valley and ran cattle, sheep, and hogs (McMath n.d.). Other settlers were located in Gravelly Valley by this time, and settlement of the upland areas became more common between 1870 and 1890 (Mauldin n.d.). The McMath's Elk Mountain Toll Road was constructed between 1875 and 1876, connecting Gravelly Valley to Upper Lake (Mauldin 1967, n.d.). By the mid-1870s, Gravelly Valley had a general store, hotel, post office, church, and school, although the community was never very large. In 1889, the Gravelly Valley Post Office officially changed its name to Hullville. Much of Gravelly Valley was inundated by Lake Pillsbury in 1922.

1.10 Ownership, Administration, and Land Allocation

The National Forest System land within this watershed is all part of the Mendocino National Forest. Over 20 percent of all Mendocino National Forest acreage is located within this watershed. Approximately three-quarters of this National Forest land is administered by the Upper Lake Ranger District. The remainder is administered by the Stonyford Ranger District. The BLM parcel is administered by the Ukiah District of the Arcata Resource Area. (See Table 1-1 below, and Plate 2 at the end of this report.)

The federal lands were divided into land allocation categories by the Record of Decision for the FSEIS (see Section 2.1). Each land allocation category has different standards and guidelines that govern its management. Management issues related to these allocations will be addressed later in the document. Specific land allocation categories as set forth by the Record of Decision for Amendments to Forest service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl ("the ROD") (USDA FS and USDI BLM 1994b) are shown in Table 1-2 and in Plate 3.

Table 1-1. OWNERSHIP AND AREA WITHIN THE WATERSHED

Ownership	Area (acres)	% of Watershed
National Forest	187,784[1]	84
State and Private Land	35,538	16
Bureau of Land Mgmt.	39	<1
Total Area	223,361[2]	

[1]Includes 1,946 acres of Lake Pillsbury, most of which is really private.
[2]Approximately 349 square miles.

Table 1-2. ROD LAND ALLOCATION TYPES AND AREAS WITHIN THE WATERSHED

Allocation Type	Area (acres)	% of Watershed
Congressionally Reserved Areas		
Wilderness Areas (Snow Mtn.)	11,523	5
Late Successional Reserves		
Mapped	78,506	35
Unmapped	600	<1
Adaptive Management Areas (AMAs)	None	
Managed Late Successional Areas	None	
Administratively Withdrawn Areas		
Research Natural Areas[1]	981	
Interim Riparian Reserves		
Within Wilderness	6,038	3[2]
Within Late Successional Reserves	43,664	20[3]
Within Research Natural Areas	575	<1[4]
Within Other lands[5]	58,361	26[6]
Matrix[5]	39,422	17[7]

1 970 of these acres are in LSR RC313
2 52% of total wilderness acres within the watershed
3 56% of total LSR acres within the watershed
4 59% of total RNA acres within the watershed
5 Includes released roadless ("RARE-II") areas. In 1973, the Mendocino National Forest inventoried all roadless areas on the Forest for possible inclusion into the National Wilderness System. The 1984 California Wilderness Act created the Snow Mountain Wilderness, and released the portions of the original Snow Mountain, Elk Creek and Skeleton Glade Roadless Areas in this watershed from further consideration for wilderness designation until revision of the Forest

Land Management Plan. Some of these released roadless areas were subsequently incorporated into Late Successional Reserves (LSRs) under the President's Plan. None of the 14,565 acres of roadless areas outside of wilderness areas and LSRs in this watershed were designated at Backcountry Areas in the Proposed Mendocino Forest Land and Resource Management Plan. Therefore, they are included in the totals for Matrix and Interim Riparian Reserves.

[6] 60% of all federal land in the watershed

[7] 21% of all federal land in the watershed

1.11 People and the Watershed

Human beings have used and continue to use the Upper Main Eel watershed for a variety of needs, including commodities, recreation, and retreat from urban areas. The intensity of these uses has varied according to natural, social, economic, and political conditions from the local to the national levels.

Gravelly Valley, which later became part of the Lake Pillsbury basin, functioned as a center for American Indian fisheries, settlement, and resource gathering. Later, the valley was a node for heavily used livestock grazing networks responding to the burgeoning national market for wool and regional market for beef. Construction of Scott Dam, itself an answer to increasing regional demand for electricity, spurred increases in local development and recreational use after the 1920s. Today, the reservoir's most valuable product may be water for irrigation in the Russian River basin. Forest road development supported by national employment programs in the 1930s and federal timber production policies in the 1950s and 1960s supported increased timber harvest. Socio-economic history and trends within the watershed will be further discussed in Chapter 7.

Areas in the watershed lie roughly two to three hours travel time by car from the metropolitan areas of San Francisco and the North Bay, with similar travel time from Sacramento. Eighty-four percent of the watershed lies within Lake County, ten percent is within Mendocino County, and six percent is within Glenn County. Access to the watershed is most frequently from the west side, most often on the access roads to Lake Pillsbury. Santa Rosa, population 113,000, is located approximately 96 road miles from Lake Pillsbury, while Ukiah lies 34 road miles southwest of the lake.

Recreation in the Upper Main Eel watershed ranges from developed campgrounds, boat ramps, and concentrated peak weekend use at Lake Pillsbury to a primitive environment and opportunities for solitude in the Snow Mountain Wilderness. As with recreation on most National Forests, camping and picnicking are the most frequent activities. Fishing, swimming, boating, and waterskiing are also popular on Lake Pillsbury. Summer and year-round homes are located at Graveyard Point, Pillsbury Ranch, and west of the Rice Fork. An unpaved, single-runway airstrip at Gravelly Valley is managed by the Forest Service under oversight by the Federal Aviation Administration. Hang-gliding has become a popular use in the last decade. Off-highway vehicle (OHV) use, predominantly motorcycles, is a popular activity in this watershed, the watershed directly to its south, and throughout the southern half of the Forest. In the northern, highest areas of the watershed recreational use is light, with hunting predominating.

2.0 INTRODUCTION TO WATERSHED ANALYSIS

2.1 Background Information on Planning and Watershed Analysis

President Clinton commissioned the development of the Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (FSEIS) (USDA FS and USDI BLM 1994a). The Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl ("the ROD") (USDA FS and USDI BLM 1994b) for the FSEIS was signed April 1994. The ROD presents a broad strategy for maintaining or restoring the distribution, diversity, and complexity of watershed and landscape-scale processes and characteristics.

A significant portion of the ROD focuses on the Aquatic Conservation Strategy (ACS) and obtaining ACS objectives. The objectives are listed in Appendix 16.2. Four components of the strategy include watershed analysis, riparian reserves, watershed restoration, and key watersheds. These components are designed to operate together to maintain and restore the productivity and resiliency of riparian and aquatic ecosystems.

Watershed analysis is a cornerstone for implementation of the ROD objectives and an important step toward landscape-scale management of forest resources. Watershed analysis has a broad, ecosystem management context. The reasons for conducting watershed analysis are embodied in the objectives of the ROD, and the ROD requires it before new management activities can take place in specific land allocations (key watersheds, riparian reserves, and inventoried roadless areas) identified in the ROD.

In most cases, watershed analysis is required in these areas before management activities can take place; the analysis is used to assist in the decision-making process. The exception is that in the short term and until watershed analysis can be completed, minor activities such as those that would be categorically excluded under the NEPA regulations (except timber harvest) may proceed, consistent with riparian reserve standards and guidelines. These are documented on pages C-31 to C-38 of the ROD (USDA FS and USDI BLM 1994b).

2.2 The Intent of Watershed Analysis

An interagency/interdisciplinary team of scientists drafted A Federal Guide for Pilot Watershed Analysis (USDA FS and USDI BLM 1994c), to be followed in completing watershed analyses. The intent is to update the guide as experience is gained.

The objective of watershed analysis is to develop and document watershed and ecological processes and interactions occurring within a watershed and identify future management opportunities. The analysis also considers economic and social considerations and identifies beneficial uses and values, key issues, and desired conditions for the watershed. This work is supposed to provide better information for project planning and decision making. Because of the linkages between headwater areas, valley floors, and downstream users, watershed analyses encompass the entire watershed, from the highest ridge to the most downstream limit, including all ownerships.

The Forest Service has embraced the concept of managing entire ecosystems and all their components and species. This includes considering the variety of human interests and uses and protecting and sustaining the natural systems that society depends on. This requires an understanding of how the requirements of various species overlap and affect one another in an area before development of a management strategy for ecosystem sustainability. Watershed analysis provides a vehicle to efficiently identify and balance multi-species concerns. This requires an understanding of the interactions between land-use activities, the physical environment, and the biological environment in an area. Integrating information on these interactions is the essence of watershed analysis.

Watershed analysis is not a decision-making process in that it does not produce a formal decision notice or record of decision as required by the National Environmental Policy Act (NEPA). Essentially, key issues, guidance for management opportunities, and unique approaches are identified in the Watershed analysis process. Watershed analysis is an intermediate level of analysis which derives information from larger-scale plans (River Basin, Provincial, Forest, District) and then provides information for reaching decisions about planned project work. Both the smaller-scale project work and the larger-scale planning are formal decision points under NEPA. Watershed analysis, and the resultant documentation of that analysis, will be one of several tools the local line officer (Forest Supervisor or District Ranger) will utilize in making management decisions about the watershed and selecting projects to implement in the watershed.

2.3 Watershed Analysis on the Mendocino National Forest

Watershed analysis efforts on the Mendocino National Forest began in June 1994 with the hiring of an Ecosystem Management Specialist to lead the Forest's watershed analysis efforts. The Mendocino National Forest assembled a core watershed analysis team between June and August of 1994. It includes a hydrologist, fisheries biologist, vegetation management specialist, wildlife biologist, and team leader. Several people are also employed to provide GIS support for the analysis effort. Additional Forest and District specialists, and representatives from other Federal agencies, make up the extended watershed analysis team. The team also maintains contact with state and local agencies, tribes, and the interested public as needed (see Section 16.1 for the list of team members and other professionals consulted).

Watershed boundaries were defined for the Forest utilizing the "Calwater" GIS watershed data base developed cooperatively by California state and federal agencies under the leadership of the California Department of Forestry and Fire Protection to produce a standardized set of California watersheds. The Mendocino National Forest includes all or part of 23 Calwater "basins" (major watersheds), all of which will eventually undergo the watershed analysis process.

2.4 The Upper Main Eel Watershed Analysis

Choice of the Analysis Area

The team began working on the Upper Main Eel watershed analysis in October 1994. The Forest proposed the Upper Main Eel watershed to the California Coastal Province Interagency Executive Committee (PIEC) as a priority for fiscal year 1996, and the PIEC concurred. Splitting the watershed into upper and lower subwatersheds to meet the ROD suggested scale for analysis of 20 to 200 square miles was considered; however, the issues are similar throughout the entire watershed and conducting two separate analyses would have greatly recuced the efficiency of the process. Therefore, the entire watershed was included in this analysis, despite the large area.

The Upper Main Eel watershed was chosen for analysis based upon: anticipated opportunities for restoration and other projects which would result in benefits for watershed health; anadromous stocks at risk of being listed as threatened or endangered (steelhead and salmon) and listed threatened and endangered species (northern spotted owls, bald eagles, and peregrine falcons); opportunities for interagency work and public participation due to the mixture of private, state, and federal lands (see Section 1.10); anticipated community needs, some of the most vocal of which have been related to the development of a Lake Pillsbury basin recreational plan, and questions as to what management activities and future employment opportunities would be associated with the watershed in the future under the ROD and the Proposed LRMP; and the presence of existing issues such as those just mentioned that require immediate attention prior to proceeding with future management activities.

Beneficial Uses

The following beneficial uses and values were identified for this watershed:

Water Quality and Quantity--A continuous supply of clean water is important to fish, wildlife, and human users. This watershed supplies water for the Potter Valley Project and downstream municipalities.

Recreational and Experiential Values--This watershed receives significant recreational use and provides diverse opportunities for recreation and experiential pursuits.

Forest Commodities--The social and economic importance of a sustainable supply of timber, firewood, and miscellaneous forest products is significant to many people.

Threatened, Endangered, and Sensitive and Special Status species--This watershed has numerous plants and animals (including fish) that merit special management considerations. Habitat for these species needs to be managed to assure viability of TES species and availability of watchable wildlife, such as neotropical songbirds, and harvestable species such as deer, salmon, steelhead, and trout.

Biodiversity and Ecosystem Health--This watershed like all others is the sum of its parts. Maintaining an array of healthy vegetative seral stages well distributed throughout the watershed will help maintain biodiversity and a healthy ecosystem. An array of seral stages is key to maintaining diverse plant and animal species and preventing large-scale losses of habitat to catastrophic events.

Public Safety and Resource Protection--Reducing the likelihood of catastrophic fire and illegal activities helps ensure public safety and protection of public resources. Ensuring that the Forest is a reasonably safe place to visit and work in provides reasonable access to all of the beneficial uses and values.

Key Issue Identification

Key issues for the Upper Main Eel watershed were developed over the course of several meetings of the full interdisciplinary and interagency watershed analysis team. Each team member came prepared with a list of those issues which he or she felt were key, based upon his or her knowledge, experience, and area of expertise.

Twelve issues or sub-issues were proposed. From these initial potential key issues, and comments received in response to a November scoping letter, the team worked together to develop and refine seven issues for further analysis. Questions considered during the development of the key issues included:

- Is the issue associated with values and uses of people?
- Is it related to restoring, enhancing, and maintaining healthy ecosystems?
- How does it fit in the larger picture (why is it important, and who is it important to?)
- What is the intensity of the issue?

The following are the seven key issues identified for detailed consideration in this watershed analysis. Each is addressed individually in Chapter 3 through 9; all of the issues are examined together in Chapters 10 through 14.

Issue 1--Anadromous Stocks at Risk (see Chapter 3)

Anadromous salmonid stocks are at risk of disappearing from the Upper Main Eel watershed. This watershed has two stocks of anadromous salmonids. Wild winter steelhead and fall chinook numbers have diminished from runs that numbered in the thousands in good years, to the 1992-94 three-year average of 3 salmon and 34 steelhead per year that have been trapped at the Van Arsdale fish ladder. The status of both steelhead and chinook are being reviewed for potential listing under the Endangered Species Act.

Issue 2--Riparian Ecosystem Function (see Chapter 4)

Natural events and past management activities have modified riparian ecosystem function within the Upper Main Eel watershed. Riparian ecosystems are a limited and important resource to a large number of riparian-dependent terrestrial and aquatic species. Riparian-dependent species of concern exist in the watershed and are sensitive to disturbances of their habitat.

Issue 3--Threatened, Endangered, and Special Status Species (see Chapter 5)

Concern exists over habitat distribution patterns and relative abundance of threatened, endangered, and special status (TE&S) animal and plant species in the Upper Main Eel watershed and their contribution toward species dispersal, viability and diversity. Naturally diverse conditions and processes combined with past management actions have created concern over habitat loss, fragmentation, spatial and temporal distribution, and connectivity. This could threaten immigration, emigration, and reproductive capabilities of local populations of threatened, endangered, and special status species. Special status species include Forest Service designated sensitive and management indicator species, neotropical migrant birds, and the survey and manage species under the Record of Decision, Attachment C, Table C-3.

Issue 4--Plant Community Changes (see Chapter 6)

Concern exists that management activities and natural processes have encouraged development of plant communities in the Upper Main Eel watershed that may be more susceptible to large-scale disturbance events and may have reduced overall ecosystem health. Wildland plant communities are dynamic, interactive groups of organisms. In addition to changes in response to natural processes, plant communities in this watershed have changed in response to attempted exclusion of fire, reforestation, harvesting, and attempted preservation. In parts of the watershed, successful fire suppression has caused changes in plant species composition, vegetation community structure, volume and distribution of downed woody material, and distribution of vegetation types at a landscape scale. In other parts of the watershed, high-intensity fires and associated reforestation and salvage logging have reset the successional clock simultaneously on large areas.

The result is a landscape that is susceptible to severe large-scale fire disturbance and insect infestation events and has a reduced and endangered compliment of key disturbance-dependent seral vegetation types.

Issue 5--Economic Opportunities (see Chapter 7)

The Upper Main Eel watershed has the potential for providing employment opportunities through resource management and restoration activities. There has been an overall reduction in commodity

outputs and a resultant lack of employment opportunities in recent years. The Upper Main Eel watershed contains 20 percent of the Forest area and has matrix land which in the President's Plan was identified as land where commodity outputs can be obtained on a sustained basis. This watershed is expected to provide opportunities to carry out restoration, achieve sustainable timber production, and support regional tourism and the recreation service industry, thereby enhancing community stability through increased employment.

Issue 6--Erosion and Sedimentation (see Chapter 8)

Erosion in the Upper Main Eel watershed has affected the characteristics of many stream channels and impacted water quality in Lake Pillsbury and water for associated downstream uses. Water quality is important for recreation, anadromous fisheries, wildlife, water storage in Lake Pillsbury, and downstream agricultural and municipal uses. Sedimentation occurs from fires, landslides, and other land-disturbing activities such as roads and trails, vegetation management, grazing, and recreation. In addition, the Upper Main Eel watershed contains soils with clays which stay in suspension for extended periods of time, resulting in high turbidity in Lake Pillsbury and downstream waters.

Issue 7--Recreation and Experiential Values (see Chapter 9)

Values and expectations expressed by various recreational user groups within the Upper Main Eel watershed vary widely, and in some cases are not currently reconciled. Cumulative impacts from all recreational uses may not be consistent with the Aquatic Conservation Strategy set forth in the Record of Decision and with sustainable ecosystem management. Recreational uses of the watershed may result in resource conflicts with, for example, bald eagles and other threatened, endangered, and sensitive species, riparian reserves, and maintenance of water quality. Additional impacts might be expected in the event of future development around the lake and improved access to the Lake Pillsbury basin.

Desired Condition Identification

Desired conditions were identified for each issue, incorporating inter- disciplinary and interagency perspectives. These desired conditions are physical and biological conditions within the watershed that should be obtainable through appropriate management activities.

Key Question Identification

A set of key questions was developed for each key issue. The key questions are those which, if answered, should guide us in moving from the current condition to the desired condition for each key issue. We were not able, nor did we anticipate being able, to fully answer all of the identified questions. However, each of the questions has been addressed to some extent during the course of the analysis. Those questions which we were unable to fully address at this time have helped us to identify important data gaps. Additional attention should be focused on filling important data gaps as we proceed toward implementation of ecosystem management at the project level.

Presentation of Analysis Results

As suggested in the FY 94-96 Federal Guidelines for Watershed Analysis, the analysis team examined past and current conditions and processes, and anticipated future trends, related to each of the identified key questions. The results of this portion of the analysis are presented in Chapters 3 through 9, by key issue.

The team then identified management opportunities related to the key issues; these are presented, along with guidance for project-level planning, in Chapters 10 through 12. Identified data gaps and monitoring needs are presented in Chapters 13 and 14, and information sources in Chapter 15. Chapter 16 includes all appendices to the report.

3.0 ISSUE 1--ANADROMOUS STOCKS AT RISK

3.1 Issue Statement

Anadromous salmonid stocks are at risk of disappearing from the Upper Main Eel watershed. This watershed has two stocks of anadromous salmonids. Wild winter steelhead and fall chinook numbers have diminished from runs that numbered in the thousands in good years, to the 1992-94 three-year average of 3 salmon and 34 steelhead per year that have been trapped at the Van Arsdale fish ladder. The status of both steelhead and chinook are being reviewed for potential listing under the Endangered Species Act.

3.2 Desired Conditions

Habitat within the watershed is capable of supporting viable populations of fall chinook and winter steelhead during all freshwater life stages.

Winter steelhead and fall chinook adult returns to the Cape Horn Dam fish ladder both exceed 500 every year. Additionally, the returns of each species equal or exceed a three-year running average of 700. [These numbers were proposed by California Department of Fish and Game biologists (California Fish and Game Commission 1994) as being obtainable and necessary to maintain viable populations in this watershed.]

Attaining the desired returns of anadromous salmonids is not prevented by introduced species, such as Sacramento squawfish (*Ptychocheilus grandis*).

Partnerships exist with other affected/affecting parties who can collaborate to improve conditions for anadromous fish in the Upper Main Eel watershed and downstream.

There is a completed Eel River Basin Plan which outlines how this watershed could contribute towards recovery and enhancement of depleted fish stocks.

Note: Adult returns to Cape Horn Dam are easy to count and show how many fish are surviving long enough to return to this watershed to spawn. Achieving these returns is dependent upon the fishery conditions in the watershed between Scott and Cape Horn Dams and the conditions downstream and in the ocean. Achieving these desired conditions will require cooperation between numerous agencies and interested partners. Existing habitat on Forest Service lands is not extensive enough to maintain viable populations of anadromous fish.

3.3 Key Questions

What are the habitat requirements for the different life stages of anadromous fish in the Upper Main Eel watershed? (See Section 3.5.)

What are the principle factors contributing to the decline in anadromous fish populations and other aquatic species within the watershed and downstream? (See Sections 3.4 and 3.5.)

What enhancement projects or changes in management would benefit anadromous fish and other aquatic species in this watershed? (See Sections 11.1, 11.2, and 12.1.)

What can we do to ensure that Aquatic Conservation Strategy Objectives are met in the future? (See Sections 3.6, 4.6, 10.1, 10.6, 11.1, 11.2, and 12.1.)

Do interim Riparian Reserve boundaries sufficiently protect fishery values? (See Section 10.1.)

What fisheries monitoring is needed for the future? (See Section 14.1.)

3.4 Past Conditions and Processes

Fish Species of Concern

Anadromous Species of Concern

Anadromous fish are spawned and reared in fresh water. They migrate downstream to the ocean to live until they return to fresh water to spawn. The Upper Main Eel watershed is known to have been an important producer of anadromous fall chinook and winter steelhead utilized by American Indians. A run of summer steelhead once occurred here (Jones 1992), but it is not expected to have been as large as that in the Middle Fork Eel watershed, where there were more abundant deep pools which were more difficult for humans to access.

It is unknown if spring chinook or coho were regularly present in the system, but Van Arsdale Fishery Station records indicate that native runs were not present after the station was established; 47 coho were seen in one winter in the 1940s (California Department of Fish and Game 1994).

Other Fish Species Important to this Analysis

The anadromous portion of the Upper Main Eel River historically contained many native species besides salmonids, including Sacramento suckers and anadromous Pacific lamprey. Both were important to American Indian fisheries. The historic community balance of fishes is unknown.

Several species of non-native fish have been introduced to the watershed during the last century. Sacramento squawfish are the most important of these species in the discussion of salmonid decline in this watershed. Some American Indians find the term "squawfish" offensive, so this species will be referred to by its scientific name, *Ptychocheilus grandis*, in the remainder of this report.

P. grandis was apparently introduced to the Eel River Basin less than 20 years ago, presumably as a live bait used in Lake Pillsbury. They were probably brought in from either the Sacramento or Russian River watersheds where they are native. These fish spread throughout much of the Eel River system. As their abundance increased, the abundance of native game and nongame fishes decreased.

Anadromous Habitat

General Aspects of the Habitat

Prior to about 120 years ago, the processes affecting the fisheries were primarily natural, except for the fire regime. It is believed that American Indians set fires regularly in this watershed to create better conditions for their hunting and gathering (see Section 5.4) (Supernowicz 1995). The American Indian reliance on fish in the Eel River for part of their subsistence and historical accounts of large runs of fish imply that this management did not damage the health of the fisheries.

Large floods, drought, landslides, and fires were probably the primary disturbances to fishery resources up to the 1860s. However, changes in land management that came with the early settlers began to alter the processes that affect the fisheries (Meehan 1991). All anadromous habitat was impacted to some degree by

human activities. Grazing, dams and water diversions, roadbuilding, timber harvest, an altered fire-regime, and introduction of non-native species have all had an effect on the fisheries. These altered processes are explored in more detail later in this Chapter and in Chapters 4, 6, and 8.

Written records of historic salmonid abundance and habitat use in the watershed prior to dam construction were not located. It is believed that historic salmon and steelhead runs were large, due to the presence of numerous American Indian village sites along streams in the watershed. Salmon Creek, Bear Creek, Rice Fork, and Corbin Creek are thought to have been among the most important spawning and rearing tributaries in the watershed prior to the construction of the dam.

Special Tributary Considerations

Soda and Bucknell Creeks has are the largest anadromous tributaries in this watershed. They have provided habitat for both salmon and steelhead. With the introduction of *P. grandis* into the main river, Soda and Bucknell Creeks took on greater importance as potential habitat for the anadromous species of concern in this watershed. Limitations to use by salmonid species have included barriers to fish passage and low summer flows. In the recent past they have been used only by steelhead, as the salmon which would normally enter the creek have been trapped at the fish trapping station at Van Arsdale. Also, Soda Creek has aggraded with gravel in past flood events, resulting in a channel which is braided (split into several shallow channels). The most seriously braided area is in the lower half mile of the creek above the confluence with the Eel River. In this area, gravel deposits have created a barrier to upstream migration except during high water flow events. This condition was thought to be especially limiting to salmon, which would be spawning earlier in the year.

Problems with the channel conditions in the lower creek are thought to have been created or worsened decades ago, when road construction rerouted and modified the lower creek. The California Department of Fish and Game conducted a project in 1970s to remove excess gravels from the wide mouth of the creek, to ensure fish passage. Subsequent storms deposited additional bedload and limited passage again. Past restoration work by the Forest Service in Soda Creek included some streambank protection, willow planting, and barrier mitigation.

The Potter Valley Project

The Project

The Potter Valley Project consists of two dams and a tunnel which diverts water from the Upper Main Eel River. Scott Dam stores water in Lake Pillsbury for subsequent release. Scott Dam is not equipped with turbines to general electricity; rather, lake water moves into a needle valve and is discharged into the river near the base of the dam. The relatively small Cape Horn Dam is located about 12 miles downstream of Scott Dam. The reservoir that Cape Horn Dam creates (Lake Van Arsdale) is used to divert water into a tunnel. Power is generated by this water, which is diverted into the Russian River watershed. The diverted water is also used for irrigation and drinking water for several municipalities (see Section 7.5 for further discussion).

Anadromous habitat was greatly reduced by the creation of Scott Dam in 1921. Fish ladders were not constructed due to the height of the dam, technical difficulties, and projected costs. About 100 miles of anadromous fish habitat were made inaccessible to returning salmon and steelhead. Return of nutrients via fish runs from below Scott Dam to the upper watershed was lost.

All anadromous fish lost access to important upstream spawning habitats. There were no good refugia left for adults that would have summered inland before spawning, such as summer steelhead. Loss of access

to this extensive habitat significantly reduced natural juvenile steelhead rearing habitat. At the same time, it improved juvenile steelhead summer rearing habitat in the river between Scott Dam and Cape Horn Dam.

Upstream migrants could only reach the anadromous portion of watershed remaining above Cape Horn Dam via a fish ladder over the dam. The fish ladder did not effectively attract all upstream migrating salmon, according to snorkel surveys that noted salmon which never tried to ascend the ladder. The ladder was modified in 1987 to effectively attract all spawners.

Flows and Temperatures

There are no records of what stream flows and temperatures were prior to European settlement, but it can be inferred from the physical features of the watershed, the prevalent weather conditions, and the salmonid species known to be present. The watershed likely had extremely high peak flows and fairly low summer flows. However, it is believed that flows used to be higher and water temperatures lower in the summer than existing conditions allow (see Chapter 4). This would be true for most of the watershed except where Scott Dam now increases flows and decreases temperatures in the summer (see Section 3.5).

It is unclear if the water was historically cool enough to rear juvenile steelhead in the lower portions of the river during the summer. Water temperatures could have been limiting to adult and juvenile salmonids in the lower river from mid-June to September when flows would have been lowest and air temperatures highest. Thus, the many pools in the lower river may not have been appropriate summer habitat for salmonids. Summer water temperatures in this basin were likely higher than what is preferred for coho rearing due to relatively low elevation of this watershed and high summer air temperatures. Lack of sufficient cool water and deep pools may be why spring chinook adults are not known to have over-summered here.

Loss of Fish into the Diversion

Since 1921, the diversion at Van Arsdale has not been effectively screened. Numerous juvenile salmon and steelhead have been diverted into the Russian River system, and this is one factor that has led to declining anadromous returns. The rate of fish loss is related to the relationship between mainstem flows, the amount of water diverted, and outmigration timing. One-year-old or older juvenile steelhead have a longer window to outmigrate than juvenile chinook salmon, which would not generally smolt (metabolically transform into a state that can survive in salt water) until flows began to drop. The volume of water diverted into the Russian River would not divert a significant number of fish during peak flows. At lower flows, the majority of juvenile outmigrants were probably lost into the diversion or due to the high temperatures in the Upper Main Eel River. These diverted fish were not expected to survive to reach the ocean.

Hatchery Augmentation

Information covering several decades is available on spawning returns to the Cape Horn Dam/Van Arsdale Fishery Station, but hatchery augmentation both above and below the dam makes it difficult to determine what "natural range" of spawners would have been expected to return to the watershed following dam construction. Adult salmonids were placed upstream of Scott Dam from the 1940s to the 1950s. Hatchery-reared juveniles were placed upstream of the Dam from the time it was completed until a few decades ago. The efficacy of this work was never firmly established. It is known that summer conditions in Lake Pillsbury are not conducive to good salmonid growth.

Downstream fish passage over the dam or through the needle valve would likely have resulted in some injuries and/or mortalities. Also, it is unclear if juvenile fish could readily find the outflow when Lake Pillsbury is not spilling water. However, tagged trout measuring about 4-8 inches were released in Lake Pillsbury and found

downstream of the dam. They apparently passed through the needle valve, according to a study conducted by the California Department of Fish and Game in 1957 (Wendy Jones pers. comm.).

3.5 Current Conditions and Processes

Fish Species of Concern

Anadromous Species of Concern

Anadromous fish have suffered declines throughout California and the Pacific Northwest. Anadromous salmonids are listed in Appendix J2 of the FSEIS ROD as species for which the Forest Service should provide additional consideration and analysis during planning. Petitions have been filed to list coho and steelhead as threatened species under the Endangered Species Act. Additionally, the National Marine Fishery Service has recently initiated a comprehensive status review of all anadromous stocks that have not yet been petitioned for listing under the Endangered Species Act.

There are numerous factors contributing to this decline both in this watershed and downstream into the Pacific Ocean. Some of the factors are: habitat loss and alteration due to natural processes (fires, floods, droughts, landslides) and past land management activities (road building, timber harvest, grazing); water diversions; competition with and predation on juveniles by introduced species; predation on adults and juveniles by marine mammals; ocean commercial and sport over-harvest; illegal fishing; and poor oceanic conditions such as El Nino.

The number of adult salmonids returning to this watershed is significantly affected by natural processes and human management that occur downstream of this watershed. Conditions and trends downstream of this watershed are not examined at great length in this document as they are more appropriate for basin and regional analyses. The Forest Service has little opportunity to effect change on factors downstream of National Forest System lands and/or outside of our administrative authority, except via partnership opportunities such as those examined in Section 12.1.

Fall Chinook Salmon

Salmon are not as adept at passing barriers as are steelhead. They enter the watershed and spawn in the fall. Fall chinook young-of-the-year normally emerge from the gravel in the late winter. They rear in the streams until the majority out-migrate in spring. This early migration allows the juvenile chinook to escape downstream prior to the onset of high summer water temperatures which can be lethal to juveniles.

Fall chinook appear to be able to access only about 14 miles of habitat within the watershed, primarily in the main river, due to low flows and natural barriers in the tributaries. This habitat is mainly on private land. The status of chinook is being reviewed by the National Marine Fishery Service, but they have not been petitioned for listing under the Endangered Species Act.

Fall chinook are still found in the watershed, but their populations have been in decline for an extended period. The current numbers of adult fish returning to spawn are far short of the 300-500 fish that geneticists believe are needed for long-term population viability. The Van Arsdale Fishery Station's records on fall chinook show that, since 1955, spawners have only met these numbers during one four-year period in the mid-1980s. (Refer to the subsequent discussion on the effects of the Potter Valley Project for some of the causes of these low returns.) It is unclear why those returns were so successful during that four-year period. Returns were generally higher coast-wide during that period. The Potter Valley Project flow schedules had been altered prior to the mid-1980s to try to benefit anadromous fish. Also, the drought had not yet begun and *P. grandis* were not yet as numerous in the Eel River Basin when those salmon outmigrated to the ocean as juveniles.

Winter Steelhead

Compared to salmon, steelhead have a good ability to jump barriers and can spawn farther upstream and in smaller tributaries. Compared to salmon, steelhead also make more extensive use of the rearing habitat. Juvenile fish generally live from 1 to 3 years in fresh water before migrating out to the ocean. Maximum summer water temperatures should not exceed the low 80s to assure juvenile survival, but somewhat lower temperatures still stress these fish. Fish scale analysis has shown that the majority of steelhead that survive to reproduce spend 2 years or more in fresh water before migrating to the ocean. Juvenile steelhead compete with each other for living space; numbers in excess of the habitat carrying capacity tend to disperse downstream.

Winter steelhead have access to about 26 miles of spawning and rearing habitat in the watershed. Surveys indicate that spawning occurs mainly in tributary streams; spawners appear to go as far upstream as they can. The majority of the successful rearing in recent years has been in the tributaries as well. The majority of this tributary habitat is on National Forest System lands.

The data on steelhead show that spawners have met or exceeded 300 to 500 fish in almost all years from 1933 to 1988. Lack of data about hatchery augmentation prior to the last decade makes it uncertain if these runs were significantly dependent on hatchery augmentation. Steelhead returns dropped significantly from 1976-77 to 1979-80. This may be related to the drought in the late 1970s. The steelhead returns dropped again beginning in 1988-89. It was about the at this time that a drought began and Sacramento squawfish populations began to expand throughout the Eel River Basin.

A petition has been filed with the National Marine Fishery Service to list winter steelhead as a threatened species under the Endangered Species Act. The numbers of adult fish returning to spawn here since 1989 are far short of the 300 to 500 fish that geneticists believe are needed for long-term population viability.

It is possible that residual steelhead remain upstream of Lake Pillsbury, and that they use the lake as their "ocean". This is unconfirmed, and anecdotal references state that such a population may have existed but has gradually died out over the years. During the summer, low oxygen conditions in the cool, bottom water of Lake Pillsbury are not conducive to salmonid growth or survival. Also, hatchery rainbows have been and are stocked upstream of Scott Dam, so that introgression with wild stocks is possible. Without additional data, no conclusions can be reached as to whether or not residual steelhead exist upstream of Scott Dam.

Summer Steelhead

Summer steelhead are no longer found in this watershed. Summer steelhead are only found in California streams with remote, deep pools (Roelofs 1985). Suitable habitat for viable populations of summer steelhead does not currently exist in the watershed.

Other Fish Species Important to this Analysis

In addition to the anadromous salmonids, the anadromous portion of the Upper Main Eel River contains many fishes, including: resident rainbow trout, California roach, Pacific lamprey, Sacramento suckers, sculpin, bluegill, green sunfish, and *P. grandis*. Juvenile salmonids in the main river must share their habitat with these other species and are faced with competition and predation by these other species. Only resident trout and steelhead are known to exist throughout most of the tributary streams. This partitioning of habitat keeps competition with, and predation by, other species limited in the upstream anadromous reaches used by steelhead.

P. grandis is a predator that can tolerate warmer temperatures than salmonids, but can tolerate cold water as well. Water temperatures in the watershed have not precluded their success as they are quite numerous in Lake Pillsbury, some of its tributaries, and downstream in the river. *P. grandis* are also abundant downstream of this watershed.

As juveniles, *P. grandis* compete with many other species, including salmonids. Adults become increasingly piscivorous after they reach about 1 foot in length, and can grow to over 3 feet in length. Adults are primarily ambush predators and prefer deeper water and submerged hiding cover. They have a high fecundity (Moyle 1976) and spawn in rivers, creeks, and occasionally in reservoirs (Kimsey 1964). Brown and Moyle (unpublished manuscript) have hypothesized that *P. grandis* should not prevent recovery of anadromous fish populations if habitat improvement occurs. However, the waiting period for such a recovery to occur is debatable, due to the fact that salmonid stocks are so severely depressed now, and that habitat recovery may take many years.

Introduction of *P. grandis* appears to have had a serious negative effect upon salmonid returns to the watershed. The river between the two dams formerly provided rearing habitat for numerous juvenile salmonids, but now supports relatively few salmonids. The California Department of Fish and Game has shown that there is a strong correlation between the decline of the Upper Main Eel watershed salmonid fishery and the introduction of *P. grandis*. CDFG is in the process of writing a draft Environmental Impact Report to eliminate *P. grandis* from above Lake Pillsbury to Cape Horn Dam. They propose to use rotenone, a chemical whose toxicity toward many aquatic gill-breathing organisms varies according to the concentration applied (California, State of 1994). Detailed analysis of this project is outside the scope of this document.

Many other types of *P. grandis* control measures have been considered or tried so far: *P. grandis* fishing derbies and bounties; trapping of *P. grandis* as they move upstream to spawn; explosive charges set off in pools with high concentrations of *P. grandis*; and planting of bass in Lake Pillsbury to increase predation on juvenile *P. grandis* (Baskerville-Bridges, et al. 1989). These methods have not significantly reduced the numbers of *P. grandis* to date.

Most fishery experts agree that this problem should be dealt with aggressively in this watershed. *P. grandis* are a non-native species that has had a negative impact on native species, including salmon and steelhead.

The state believes that chemically treating the river downstream of Lake Pillsbury to the Van Arsdale Fishery Station, Lake Pillsbury, and tributary streams as needed, may be the only solution to this problem. Some fishery experts question if the state can ever permanently remove *P. grandis* from these waters. It would probably require more than one fairly expensive chemical treatment to eliminate all of them. Also, there is the threat of reintroduction following successful treatment; one person with a bucket and a few juvenile *P. grandis* could reintroduce these fish to the lake and/or the river downstream.

An alternate strategy suggested by some fishery experts is to make the best of the existing situation. This would be necessary downstream of Van Arsdale even if the rotenone project were pursued and were successful. Fishery experts advocate intensifying efforts to kill adult *P. grandis* to minimize potential spawners. Identifying locations and methods to make these fish more vulnerable to control methods is being studied by researchers. Increasing the public interest in *P. grandis* via fishing derbies and increasing the sport harvest of *P. grandis* is worthwhile; it actively involves the public in the effort to control these fish and creates an additional recreational fishery. The additional fishery could have a positive effect on local economies.

Strategies to deal with this problem are further discussed in Section 12.1.

Anadromous Habitat

General Aspects of the Habitat

Location

About 12 miles of anadromous habitat remains on the Upper Main Eel River and about 14 miles of habitat exists on tributaries (Plate 4). The main stem is about 90 percent privately owned and the tributaries are about 15 percent privately owned. The remainder of these stream miles are managed by the Forest Service. Viable populations of salmonids would require more extensive habitat than is available now on Forest Service habitat in this watershed.

Anadromous fish moving to or from Forest Service habitat must cross through private lands. This analysis considers habitat conditions and processes on both public and private lands, since salmonids don't necessarily follow our human boundaries.

Effects of Erosion and Sedimentation

Road and OHV trail location, density, and design are causing elevated sedimentation and erosion rates in some parts of the watershed; roads have higher impacts than designated, maintained OHV trails. Unplanned recreational use along the river also impacts riparian fish habitat. See Chapters 4, 8, and 9 for further discussion of riparian and fishery concerns related to sediment and erosion and recreational use.

Most of the erosion within the upper watershed has little direct effect on the anadromous fisheries. Lake Pillsbury acts as a sediment-settling pond for the majority of the erosion that takes place upstream of it. Most of the sediments that pass through the lake continue downstream and are not deposited within this watershed.

Erosion that takes place in the watershed downstream of Scott Dam does have a direct effect on anadromous fisheries. Sediment deposition is apparent in Lake Van Arsdale. Sediment fills interstices in the substrate, reducing the available space for aquatic insect production. Therefore, excess sediment lowers food availability for fish.

In addition, excess sediment can decrease available spawning sites and limit survival of salmonid eggs and young. However, this does not appear to be a critical problem in the river. Amounts of sediment and fine gravel are elevated in some areas, but spawning gravels are available between the two dams.

Large Woody Debris

Instream cover, shade, and amount of large woody debris (LWD) are less than optimal in the watershed. Lake Pillsbury does prevent LWD from being transported from the upper watershed to the river below Scott Dam. However, it is likely that most LWD does not persist long on the main river, due to the high flows during flood events. LWD is expected to be more persistent in the tributaries.

Wood serves as a major roughness element in the development and maintenance of channel morphology. In smaller streams, LWD is a primary component in pool formation. A key function of LWD relative to salmonid production is its role in the maintenance of aquatic habitat diversity and complexity. LWD serves as a preferential cover component for salmonids in pools, as well as a drop structure, forming small waterfalls which create feeding sites and cover from predation. Large woody debris functions not only as an element in the formation of stream habitat, but also in sediment sorting and storage, habitat for aquatic organisms,

and a source of organic material providing energy for the aquatic food web. LWD is essential to ensure availability of adequate cover and suitable habitat over a wide range of climatic and flow conditions.

The river and all tributaries have less instream woody debris than would be optimum for fish needs (based on qualitative visual inventories). This impacts many of the critical instream processes and values described above. Due to the shortage of large trees adjacent to the anadromous streams there is currently a lack of recruitment of riparian vegetation. However, lack of LWD does not appear to be among the most significant limiting factors at present. (See Chapter 11 and Section 12.1 for a discussion of work needed in this watershed.)

Habitat Suitability with the Presence of *P. grandis*

P. grandis predation causes salmonids to utilize habitats safer from potential *P. grandis* ambush (Brown, et al. 1991), which include fast-flowing riffles and shallower waters. The Upper Main Eel River habitat conditions, which include numerous large boulders and occasional LWD in the numerous deep pools (which would normally be preferred by salmonids), are not currently favorable for salmonids. The high turbidity in the Lake Pillsbury discharges does not appear to provide salmonids with sufficient cover for them to utilize the extensive pool habitat as they did before the arrival of *P. grandis*. Given the existing *P. grandis* problem, it might be better for salmonids if riffle and other shallow water habitat and microhabitat in the main river were more extensive. This type of habitat is more limited, as is hiding cover in these habitat types. Unfortunately, the flows and geomorphology in the main river do not make habitat alteration very viable there.

Special Tributary Considerations

Due to the presence and effects of *P. grandis* in the main river, tributaries have great value for salmonid spawning and rearing. Anadromous tributaries (primarily Soda and Bucknell Creek drainages) are probably the cornerstone to the limited natural production of steelhead in the watershed. Adult *P. grandis* are not intruding far into these streams, which allows some juvenile steelhead to grow big enough to minimize predation when they disperse downstream. The summer flows in these tributaries are less than 1 cubic foot per second. Juvenile steelhead abundance in these small tributaries is roughly equal to that in the river between the two dams, even though the volume of habitat in the tributaries is less than one percent of that in the river (Steiner Environmental Consulting 1994, Steiner pers. comm.).

Low summer flows in these tributaries increase the need for long-term management directed at creating or maintaining healthy riparian conditions. The water temperatures are acceptable for salmonids; however, maximum water temperatures at the downstream end of these tributaries are high enough to stress juvenile steelhead. Nongame fish, including *P. grandis*, are found in these warmer reaches. The majority of the tributaries are fairly well shaded, so it is unlikely that riparian enhancement projects could reduce water temperatures in the short term. The tributaries are somewhat deficient in pool abundance and depth and LWD availability, according to fishery inventories.

Low summer flows are probably the chief factor limiting the amount of fish these tributaries can support. Most of the tributary habitat is characterized as healthy and stable. Considering the summer low-flow conditions, the tributaries are probably at about carrying capacity, according to Mendocino National Forest Fishery Biologist Emil Ekman (pers. comm.). Fish growth in these reaches is probably slowed by the relatively high abundance of juvenile steelhead related to the available food supply and living space in the stream.
Natural barriers make the majority of Welch and Benmore Creeks inaccessible to anadromous fish. Fish can't get above these barriers at any flows. However, limitations of summer flows and the length of habitat available above these barriers makes mitigating these barriers not very cost effective.

Soda Creek is an important source of spawning gravel for the Upper Main Eel River; its value for spawning gravel is especially important in light of the fact that Scott Dam prevents recruitment of upstream spawning gravel.

The natural processes in Soda Creek will continue to deposit significant amounts of bedload near the confluence with the Upper Main Eel River. This is due to the fact that high flows in the river during flood stage can create very low hydraulic gradients and water velocities in Soda Creek near the river. This causes bedload moving downstream in Soda Creek to be deposited there.

Following a Preliminary Watershed Restoration Assessment in 1994, the Forest Service began to construct instream log, boulder, and willow structures to better define the stream channel and benefit the fisheries by improving fish passage. This work was begun at the upstream end of the braided reach and extended downstream about .25 miles. Roughly 1.75 miles of stream remain between this work and the river.

The work was severely damaged in a January 1995 flood, but the project area now has a more defined stream channel than it did before the project was implemented. Subsequent analysis showed that the geometry of the stream and the high bedload transport make it difficult to successfully pursue projects in that stream channel type.

The Potter Valley Project

The Project

Many reports have been prepared on the effects of this project, including those done by VTN (1982) and Steiner Environmental Consulting (1994), which merit review by people interested in this project. Cal Trout is funding a river streamflow study that involves this project, but this report has not yet been released.

The majority of former anadromous fish habitat above Scott Dam would still be usable by fish if they could access it. However, stream and riparian conditions have been altered by natural and human disturbance to result in higher summer water temperatures and lower summer flows (see below, and Chapter 4). The watershed can no longer support as much rearing and spawning as it once did. About 10 miles of former anadromous habitat just upstream of Scott Dam was inundated by the dam building, and impacted by subsequent erosion and sedimentation.

This project has had a role in the decline of salmonids (especially salmon) in the Upper Main Eel watershed, but it should be remembered that prior to the introduction of *P. grandis*, steelhead juvenile survival and subsequent returns to the watershed were much higher. Also, this project has had both negative and positive effects on salmonids. It appears that viable steelhead stocks could have been compatible with this project before the introduction of *P. grandis*. Also, it appears that continued project modifications could make the project more compatible with salmonids.

Flows and Temperatures

The Potter Valley Project has altered water temperatures and the natural flow regime, including the timing of certain peak flows. These changes are believed to impact fish behavior and survival. Scott Dam was not designed to store much water in excess of what was needed for diversion into the Potter Valley Project. Storage capacity has affected management decisions on flow volume and timing. Greater storage capacity would allow more flexibility in allocating the water stored in the lake and its beneficial uses.

After the summer drawdown, Lake Pillsbury begins storing water in the fall. Until the lake is completely full, peak flow events above the reservoir are buffered by the lake's storage capacity. This limits fall and early

winter flows which would have provided environmental cues for spawning salmonids. The extent of the effect of this alteration is unknown. The situation probably has more of an effect on chinook salmon, because they spawn first.

The reservoir-controlled spring flows and temperatures also do not mimic natural conditions. The project's buffering of spring storm events and modification of the normal spring hydrograph and water temperatures alter the environmental cues that cause the juveniles to begin their outmigration. The timing and rate at which flows are diminished below Van Arsdale in June don't approximate natural processes. Salmonids that outmigrate too late are much less likely to survive. This would probably most affect chinook salmon, as they normally develop and outmigrate in their first year.

PG&E has worked with the state to release lake water to try to improve both the fall and spring problems, but the volume of water available for this is limited and the efficacy has not been established.

It is possible that lack of natural fall and spring flows due to the Potter Valley Project is limiting salmonid fisheries in other parts of the Eel River basin. Lack of cumulative flows to trigger, and increase the survival of, spawning runs and juvenile outmigrants would be especially likely in a drought.

Not all of the project's effects are negative. Lake Pillsbury acts as a heat sink in the winter, slightly raising river water temperatures; this improves early juvenile development. Spring and summer salmonid growth rates are very good between the two dams. Steelhead growth rates between the two dams approximates what could be obtained in a hatchery (approximately 1 inch per month).

The Potter Valley Project results in very good summer flows (that range between about 140 and 300 cubic feet per second) and summer temperatures (mean about 16-20 degrees C, or 61-68 degrees F) in the Upper Main Eel River between Scott and Cape Horn dams (Steiner Environmental Consulting 1994). These conditions would not exist without Scott Dam. A good part of the habitat upstream of Scott Dam is not currently suitable for salmonids year-round. A combination of natural and human alteration has occurred in the riparian habitat in many of the tributaries (see Chapter 4). Summer water temperatures are high and summer flows are low, as the tributaries reach Lake Pillsbury. It is only because of Scott Dam's storage capacity and cool releases that the river between the two dams provides cool summer water temperatures for salmonids.

Downstream of Cape Horn, the situation is different; flows in the river below Cape Horn Dam are often as low as 6-7 cubic feet per second during the summer months. This approximates the low flows that would be expected without Scott Dam's storage capacity, but as stated earlier, not the timing. These low flows don't provide suitable water temperatures for downstream coldwater fisheries. The potential for downstream salmonids to survive the hot summer months is extremely limited until the river approaches the coast.

Fish Lost Into the Diversion

Few steelhead are believed to have been lost into the diversion in recent years. Data extrapolations by PG&E biologists indicate that the number of additional adult steelhead that would have been produced had a fish screen been in place would have varied from a high of 5 fish, to a low of .3 fish per year, with a total of 12 fish for five years (1988-89 to 1992-93) (G. Geary, pers. comm.). The reason few steelhead are estimated lost to the diversion in recent years is that few steelhead are outmigrating from this watershed, presumably due to the effects of *P. grandis*.

It is possible that a small number of spawning fish in the Russian River have mistakenly come up the Russian to spawn, rather than swimming up the Eel. One hypothesis is that some native Eel River fish could be attracted to the diverted waters. If Eel River adults returned to the Russian River, they would not be able to reach the Eel to spawn. However, most of the available data do not support this hypothesis, and definitively marked Eel River fish have not been found in the Russian River.

Work is currently under way to screen this diversion. This is a multi-million dollar job and is expected to be complete in the fall of 1995.

Hatchery Augmentation

The California Department of Fish and Game operates the Van Arsdale Fishery Station which is located at Cape Horn Dam. All fish trying to ascend the fish ladder can be captured for examination. Work at Van Arsdale has shown that steelhead yearlings raised in a hatchery are returning at higher rates than wild yearlings generally do. Hatchery-raised yearlings are much larger than wild yearlings reared in the tributaries in this watershed and presumably better able to escape predators. Growth rates in the river between the two dams are comparable to hatchery rates, but the numbers of steelhead produced there have dropped since *P. grandis* became numerous.

Low wild salmonid returns in the last decade have raised the fear that the Upper Main Eel watershed may no longer have self-sustaining genetically viable stocks of salmonids. The state has embarked on a program to capture all of the wild chinook and steelhead at Van Arsdale, artificially spawn a portion of the run, and propagate their offspring. The program is still new and is planned to be adjusted as resource needs dictate. The state doesn't have facilities within the watershed suitable for this project, so these fish are planned to be raised at two locations, the Mad River Hatchery near Arcata and the Warm Springs Hatchery near Healdsburg. Raising the fish in two different locations reduces the risk of "putting all of your eggs in one basket." Progeny from different parents will be separately tagged so that the state can do their best to manage for genetic variability. It is hoped that populations can be recovered to the point that hatchery augmentation will not be required to maintain viable populations.

Some biologists fear that improperly managed hatchery operations can harm, rather than help, depleted stocks. Some of the publics interested in this analysis voiced this concern, and expressed a desire to ensure that hatchery operations didn't reduce the genetic diversity and population viability of the wild salmonids. The Van Arsdale fish ladder and trap allow control of which fish are returned into this watershed to spawn naturally, and which are selectively bred. This provides a number of options to fishery managers related to the balance of wild and hatchery spawning, assuming sufficient numbers of spawners return.

In addition to this hatchery effort, the state has modified fishing regulations to try to ensure that more adults survive to spawn. The changes also reduce potential angling pressure on juvenile steelhead, so that more young fish should reach the ocean to continue rearing. These changes may have already obtained increases in spawners.

More than 120 wild steelhead are expected to return to spawn this year. As of 18 April 1995, 110 have been caught; 21 females were retained to spawn when their eggs were ripe. The 21 males needed to fertilize the females' eggs were retained to spawn once and released upstream of Van Arsdale. An additional 15 males and 53 females were released above Van Arsdale to spawn naturally. It is unknown where these fish spawned, but usually they go as far up the tributaries as possible. The fish selected for spawning were retained from different stages of the run to try to increase variability among the hatchery-reared fish.

An additional 277 half-pounder steelhead have returned this year; about 10 of these were wild fish. (A half-pounder is a steelhead that spends less than a year rearing in the ocean before returning to freshwater.) It is estimated that about 5 percent were female, and both females and males were released above Van Arsdale. These half-pounders appeared to be sexually mature according to Van Arsdale Fishery Station Manager Allan Grass (pers. comm.).

It is possible that over 40,000 juvenile steelhead will be produced for future release. They will be raised to yearlings to increase the chance of their survival. Then they will be returned and released at Van Arsdale in

the spring during flushing flows. Imprinting them on their natal watershed should cause them to return here to spawn.

Wild adult salmon returns have increased modestly this year. During the 1994-95 spawning season, 2 female and 19 male chinook were captured and spawned. This is the first year in the last four that chinook returns included both sexes, which had an obvious effect on recruitment. As a result of this capture and artificial spawning, it is expected that more than 3,000 juveniles will be produced and released at Van Arsdale.

The timing of juvenile salmon release is still being discussed between the state and its partners and publics. It is possible that some young-of-the-year would be released in spring and the remainder would be released as yearlings in the following spring.

3.6 Future Trends

Increased partnerships and cooperation in the Eel River basin are likely. Many agencies and private parties are interested in enhancing the Eel River salmonid fisheries.

Fish Species of Concern

Anadromous Species of Concern

The existing trend of low anadromous returns to the Upper Main Eel is not expected to significantly change without continued special attention to the management of the fisheries, both within the watershed and downstream of it. This could result in a permanent loss of viable populations of the wild stocks of fish adapted to this watershed. The risk of losing viable populations is higher for salmon than for steelhead.

Alternatively, appropriate management actions (especially coupled with improvement of ocean conditions) could result in a strong comeback of the depleted salmonid stocks. Existing conditions make increases in adult steelhead numbers easier to attain than increases in adult chinook.

Other Fish Species Important to this Analysis

Efforts to control *P. grandis* predation and competition are expected to continue. Other types of management projects to increase salmonid numbers in this watershed will not likely obtain significant results if *P. grandis* control measures are not employed.

P. grandis will likely have a significant effect on the fisheries in the entire Eel River Basin. It is likely that they cannot be totally eliminated from the Eel River Basin; they will probably always have an effect on the fishery, even if eliminated from this watershed by a chemical treatment. Even if the state can chemically eliminate exotic, unwanted fish species from Lake Pillsbury and the river between the two dams, it is possible that the state will be unable to prevent reintroduction of *P. grandis* or other exotic species. Continued illegal movement of fish is a possibility.

Anadromous Habitat

General Aspects of the Habitat

Refer to Section 4.6 for future trends related to riparian ecosystem function, as this affects anadromous fishery values. Also see Section 6.6 for future trends related to fire and its effect on plant communities and Section 8.6 for future trends related to fire, flooding, and erosion.

Under current conditions, the watershed does not provide good refugia for stocks at risk, nor does it have numerous anadromous fish, so it was not designated a key watershed. If the most limiting conditions could be changed, this watershed could provide a new cornerstone for recovery of depleted anadromous stocks.

The lack of current recruitment of riparian vegetation in some portions of the watershed will have an effect on the fish habitat in the future. Also, due to the shortage of large trees adjacent to some anadromous streams, the potential for future woody debris recruitment is reduced and the reintroduction of instream wood and related instream processes are delayed.

Special Tributary Considerations

The abundance and growth of juvenile salmonids rearing in the tributaries will continue to be limited by the summer low flow conditions. Pool abundance and depth and LWD availability in the tributaries could be improved in the long run by riparian enhancement projects. High flows in Soda Creek will continue to deposit significant amounts of bedload near its confluence with the Upper Main Eel River. The district is planning to pursue additional work in Soda Creek in 1995 to stabilize the 1994 project area with the addition of more boulders and riparian vegetation. The establishment of vegetation should be successful if the planting is done along areas of the stream that are stabilized. Periodic project work could improve passage for spawning chinook if and when the numbers of chinook spawners increase. Fish barriers in other anadromous streams could be removed as needed.

The Potter Valley Project

The Van Arsdale Diversion fish screen should be complete in 1995. This should stop the diversion and loss of Upper Main Eel watershed juvenile salmonids.

Further modifications of the Potter Valley Project and/or flow schedule to better mimic natural conditions in the fall and the spring could be of benefit to all salmonids, but especially to chinook. Any plans to modify flows would likely consider what natural flows would have been, what range of seasonal flows would most benefit salmonids, and what affects flow manipulation might have on other species, including *P. grandis*.

If more cool Lake Pillsbury water could continue down the river below Van Arsdale in the summer, it would be possible to support coldwater fish in a portion of the river. The extent of improvement for salmonids would be related to the amount of water supplied. However, the water gets increasingly warm as it moves downstream. One problem with proposals to augment summer flows is that increasing summer flows below Cape Horn could be of more benefit to *P. grandis* than to salmonids (Steiner pers. comm.). For example, increasing salmonids by 20 percent and *P. grandis* by 200 percent would not necessarily benefit salmonids.

Dialogue about how to best operate the Potter Valley Project to balance the different needs of people and the concerns about the fish is expected to continue (see Section 12.1).

Hatchery Augmentation

The California Department of Fish and Game hatchery work is expected to continue at Van Arsdale. The effort to balance the concern about maintaining wild runs with the concern about maintaining some level of sport and/or recreational harvest will likely receive attention from both their technical and public affairs staffs.

4.0 ISSUE 2--RIPARIAN ECOSYSTEM FUNCTION

4.1 Issue Statement

Natural events and past management activities have modified riparian ecosystem function within the Upper Main Eel watershed. Riparian ecosystems are a limited and important resource to a large number of riparian-dependent terrestrial and aquatic species. Riparian-dependent species of concern exist in the watershed and are sensitive to disturbances of their habitat.

4.2 Desired Conditions

Riparian reserves meet Aquatic Conservation Strategy (ACS) objectives (listed in Section 16.2).

Habitat maintains viable populations of riparian-dependent species; this habitat includes riparian reserves that allow dispersal throughout and between watersheds.

Linkages to adjacent upland habitats are maintained or enhanced.

4.3 Key Questions

How are riparian reserves functioning related to ACS objectives? (See Sections 4.5, 4.6, and 10.1.)

What riparian species of concern exist within this watershed? What are their habitat requirements? (See Section 4.5.)

Are exotic species that have deleterious effects on native species known to occur in the watershed? (See Section 4.5.)

What is the role of riparian reserves related to wildlife distribution and habitat connectivity? (See Section 5.6.)

Do interim riparian reserve widths meet the needs of the riparian-dependent species? (See Sections 4.5, 4.6, and 10.1.)

Which existing uses or conditions have the potential to alter riparian habitat and prevent or hinder attainment of ACS objectives? (See Sections 4.5 and 4.6.)

Which existing uses are compatible with attainment of ACS objectives? (See Sections 4.5 and 4.6.)

What types of monitoring are needed to verify that riparian reserves are meeting ACS objectives and will continue to meet them in the future? (See Section 14.1.)

What types of enhancement projects or changes in management would benefit the riparian ecosystem and riparian-dependent species? (See Sections 4.5, 4.6, 11.1, 11.2, and 12.1.)

4.4 Past Conditions and Processes

Riparian Habitat

Riparian areas are the ecotone (border) of the aquatic and terrestrial communities. They are also areas of water storage and transport. Healthy streamside riparian zones store water transported during high flow

periods and release this stored water later. Many species are dependent on the riparian habitat associated with streams, lakes, ponds, and wetlands. In accordance with the ROD, this analysis included all streams as riparian areas including first- and second-order streams which carry surface water only during periods of high runoff.

A wide variety of factors are frequently mentioned when describing the character and function of riparian zones. Large woody debris, shade, stable productive soil, cold air drainage, and organic matter all contribute to riparian conditions favorable to riparian-dependent species. The following four elements are major categories that cover a wide range of important riparian functions:

Large Woody Debris (LWD): Woody debris provides pathways for nutrient delivery to the riparian and aquatic biota; habitat structure by forming pools; instream cover; substrates for invertebrates for aquatic life; and cover for riparian-dependent species. It affects the movement, storage, and sorting of stream sediment important for spawning habitat and benthic communities.

Root Strength: Root strength provided by herbaceous plants, trees, and shrubs helps to hold soil in place, allowing soil stabilization and development, contributing to stream bank stability, and reducing sediment yield.

Particulate Organic Material: Allochthonous sources of energy (i.e. energy derived from terrestrial sources) including food, leaf litter, and other small organic debris provide energy inputs to the aquatic environment.

Microclimate: The riparian zone often acts as a thermal blanket by providing shade in the summer and retaining heat in the winter. This stabilization of microclimate is important in maintaining temperature and humidity within optimal ranges for biota throughout diurnal and seasonal fluxes.

Data on the past conditions and processes which existed within Upper Main Eel watershed riparian reserves are limited. Large floods, drought, landslides, and fires were probably the primary disturbances to riparian conditions until the 1860s. These processes affecting the riparian zone were primarily natural, except for the fire regime. It is believed that American Indians set fires regularly in this watershed to create better conditions for their hunting and gathering (Supernowicz 1995) (see also Section 6.4). The American Indian reliance on fish in the Eel River basin for part of their subsistence, historical accounts of large runs of fish, and the fact that fish are dependent on riparian health, imply that this management did not damage riparian health. Also, early written accounts of this watershed give no reason to believe that the riparian zone was not in a healthy condition historically.

Following the 1860s, Euroamerican management activities began to increasingly impact the conditions and processes of the riparian corridor on the mainstem and tributary channels. Thousands of sheep and cattle were grazed in this watershed in the late 1800s and early 1900s. Grazing during this time period caused a significant amount of damage to watershed and riparian values. Decades later, following complete removal of the sheep and decreased numbers of cattle, some areas have failed to fully recover (Supernowicz 1995). The worst of this damage occurred in what are known as "barren areas".

These areas became a problem because rain or rapid snow melt sent large volumes of water and sediment downhill and downstream in a very short period of time. This situation affected riparian health, water quality, and aquatic resources. Past attempts to plant grass, shrubs, or trees to rehabilitate these areas were not fully successful due to the lack of topsoil on site. See Section 8.4 for further discussion related to past erosion and sedimentation.

Scott and Cape Horn Dams and the Potter Valley Project diversion were built in the early part of the century. This work created Lake Pillsbury and Lake Van Arsdale which inundated about 10 miles of stream-type riparian habitat, altered the natural flow regime downstream of Scott Dam, diverted water into the Russian River watershed, and halted anadromous fish runs in the majority of the watershed. Halting these runs

stopped the replenishment of scarce nutrients to the riparian zone from fish returning from the ocean and diminished the seasonal food base for carnivores upstream of the dam. The effects on the anadromous fishery were examined in more detail in Sections 3.4 and 3.5.

Dam building also created some new riparian habitat around the margins of the new lakes; However, riparian habitat did not become established around most of Lake Pillsbury. Much of the shoreline (except at the north end) of the 2000-acre lake abutts upon upland habitat. Riparian vegetative colonization was not very successful due to the extreme range between low water and high water conditions created by operation of the Potter Valley Project.

Roadbuilding and logging began on a limited scale with the first settlers, but became much more widespread in the watershed in the 1940s. In some cases, unstable or potentially unstable areas and intermittent tributaries were impacted by road building and/or logging within what is now classified as riparian reserves. In other areas, vegetative buffers or leave strips that would not meet current standards and guidelines were used on intermittent and perennial streams. These activities, and subsequent landsliding and other erosion, affected riparian health, water quality, and aquatic resources. Impacted streams included Rock, Salt, and French Creeks.

More than half of the watershed has been burned at least once in a wildfire in the last century (see Chapter 6). These fires have had a significant impact on riparian conditions and values.

Numerous riparian and upland restoration and enhancement projects have been undertaken in this watershed in the last few decades. This work focused on reducing erosion and sedimentation to benefit riparian values.

Riparian-Dependent Species of Concern

Data on these species and their historic habitat in the Upper Main Eel watershed are limited. There is no reason to believe that their populations were not in a healthy condition historically, according to early accounts of this watershed. The riparian-dependent species of concern that will be addressed in the remainder of this chapter are: western pond turtles, northern red-legged frogs, foothill yellow-legged frogs, willow flycatchers, and four species of bats (long-eared myotis, fringed myotis, long-legged myotis, and silver-haired bat). All of these species have been known to be generally declining throughout part or all of their range for a decade or more. Anadromous salmonids (Chapter 3); bald eagles (Chapters 5 and 9); and martens, peregrine falcons, and northern spotted owls (Chapter 5) are discussed mainly in other chapters, as noted. This chapter will only focus on the eight species of concern for this watershed.

See Section 4.5 for a discussion of these species and their habitat needs. Non-native species have been moved into the watershed by humans during the last century and certain non-native species compete with and/or predate upon native riparian-dependent species.

4.5 Current Conditions and Processes

Riparian Habitat

General Description

There are over 3900 miles of perennial and intermittent stream in this watershed. In addition to Lakes Pillsbury and Van Arsdale, 39 perennial lakes and 10 intermittent lakes are mapped. These last lakes are relatively small and their combined area is just over 54 acres. Interim riparian reserves were only mapped for the riparian

reserves interspersed with matrix, but it is estimated that riparian reserves cover about 60 percent of the watershed. See Sections 1.10 and 10.1 for more information about riparian reserves.

Data on the current conditions, processes, and riparian-dependent species existing within Upper Main Eel watershed riparian reserves are available primarily from fishery and hydrology surveys. Very little data are available on meadows, small ponds, and headwater streams.

Existing data gaps make it hard to determine if some existing conditions are natural or an artifact of past disturbance. For example, many miles of the Upper Main Eel River upstream of Lake Pillsbury appear to be "unnaturally" open, with only limited riparian vegetation. This same situation can be seen in aerial photos from the 1940s. It may truly be a natural situation. Alternatively, it has been suggested that it is the result of the cumulative impacts of livestock grazing and other Euroamerican disturbance. Without more data, it is not possible to determine how far existing conditions depart from past conditions, nor what future riparian recovery rates are possible from different disturbance events.

Estimates of the amount of change that has occurred in riparian conditions and processes in the past century are difficult to assess and impacts would vary by subwatershed and stream, but it is reasonable to assume that riparian cover is reduced in much of the watershed from past conditions. Without riparian cover and the root strength associated with it, bank stability has been reduced and the potential for channel bank erosion and further stream sedimentation increased. As erosion accelerates, water storage capabilities decrease, resulting in higher peak flows and lower summer flows. Decreased riparian vegetation results in more solar input, and higher evaporation rates and water temperatures.

Changes in riparian corridor function on many of these streams has had detrimental consequences with regard to LWD availability and recruitment, although some streams, such as Corbin Creek, still have acceptable levels of wood. Wood serves as a major roughness element in the development and maintenance of channel morphology. In smaller streams, LWD is a primary component in pool formation. Lack of wood impacts many of the critical instream processes described in Section 4.4. Due to a current shortage of large trees in riparian zones, the potential for future woody debris recruitment is reduced and the reintroduction of instream wood and related instream processes is delayed.

Recent fishery and hydrologic surveys reveal differing physical trends on different streams. Many streams are in better condition in recent years than they were one or two decades ago; they have better fish habitat, more fish, and less evidence of erosion. Many other streams are in worse condition, with a documented increase in landslides and sediments and a decrease in fish habitat quality and fish abundance. Still other streams don't appear to have changed significantly in the last few decades.

The surveyors identified the causes of change in most cases. Some areas with a trend away from meeting Aquatic Conservation Strategy (ACS) objectives have been burned in the recent past or are still being impacted by natural landslides or those caused by past road-building or timber-harvest activities. Some areas with a trend toward improved riparian conditions have experienced recovery from previous impairment from natural or human disturbances such as fire, landsliding, roadbuilding, and logging. Some improved conditions are directly related to Forest Service restoration or enhancement project work that mitigated past natural or human disturbances. Livestock grazing practices and the existing transportation system need continued attention to achieve improvements in riparian conditions.

Grazing

There has been a substantial reduction from the tens of thousands of animals that grazed here historically. There are now eight cattle grazing allotments within the watershed and they lie across about 41 percent of the National Forest System lands in the watershed. The most intensive livestock use in this watershed is occurring primarily on private land within the National Forest boundary. The Mendocino National Forest has

an opportunity to improve public relations in this regard, since some publics mistakenly perceive that the private lands where this use takes place are National Forest System lands.

Current conflicts between grazing and riparian values within the National Forest portion of this watershed are few. Due to a lack of fencing throughout most of the watershed, cattle occasionally stray out of their allotments in such areas as Rice Fork and Bald Mountain. Some riparian conflicts within the watershed have also been noted in past years in the non-wilderness portion of an allotment on the southwest side of the Snow Mountain Wilderness. Areas within the wilderness which have been cited by some members of the public as having grazing conflicts, are in fact not within this watershed. High levels of use which occurred in one allotment on the Rice Fork in the recent past resulted in the permitted AUMs being reduced by about half since implementation in 1994 of new riparian standards. These standards apply to the riparian reserves, including all streams, wet meadows, and headwater riparian areas. The standards were designed to achieve compliance with the Aquatic Conservation Strategy.

Aside from the above examples, there appear to be few current conflicts between grazing levels and achievement of most ACS objectives within the watershed, although it is possible that grazing use is conflicting with the habitat requirements of certain riparian-dependent species.

Roads and Trails

Some parts of the watershed have high densities of streams, roads and trails. Roads and trails often function as first order streams by collecting runoff water and sediment and transporting it to streams. It is believed that trails have much less impact on riparian values and processes than does the road system. This is because the roads cover more surface area in the watershed, and thus concentrate and transport more water and sediment.

Information on trails in this watershed is incomplete, but there are over 175 miles of trail, including about 100 miles of designated OHV trails. Additional non-designated, unmaintained OHV trails exist as well, but no estimate of their total mileage is available. Implementation of designated trail maintenance has fallen behind schedule in recent years.

There are over 760 miles of road and about 3900 road/stream-crossings in this watershed. This situation acts to increase first-order stream miles by over 25 percent. This results in higher peak flows and erosion which can degrade riparian conditions and values.

Roads in this watershed include about 120 miles in interim riparian reserves. Of this, 2.5 miles of road are located in active landslides and about 69 miles are in dormant landslides. See Section 8.5 for a further discussion related to current erosion and sedimentation, and Section 10.6 for guidance related to transportation planning.

Fishery inventories note that culverts at some road crossings are barriers to migrating spawning fish. However, natural barriers exist on these same streams near these culverts, so this doesn't appear to be a significant problem related to meeting ACS objectives. Past surveys did not focus on identifying human-created barriers to juvenile fish upstream passage. It is possible that some culverts should be modified to allow juvenile fish access to some stream reaches; for example, juvenile trout may need to reach cooler upstream habitat when downstream waters get too warm during the summer. It is not known how well we are meeting ACS objectives in this respect.

Riparian-Dependent Species of Concern

Numerous invertebrates, fishes, amphibians, reptiles, birds, and mammals are dependent on riparian habitat. It should be remembered that many riparian-dependent species are also dependent on upland habitat for food, cover, and habitat connectivity.

Upper Main Eel watershed riparian areas are known to provide habitat for the Forest Service-sensitive western pond turtle and willow flycatcher; candidates for listing under the Endangered Species Act such as northern red-legged frogs, foothill yellow-legged frogs; and four species of bats (long-eared myotis, fringed myotis, long-legged myotis, and silver-haired bat) listed in the ROD and Appendix J2 of the FSEIS for the ROD. Special surveys have not been completed on the Mendocino National Forest for any of these species. However, all of these species are known to be generally declining throughout part or all of their range.

It is possible that the watershed contains other candidates for listing under the Endangered Species Act such as the tailed frog and Southern torrent salamander. Populations of these species exist both north and southwest of this watershed, however the type of habitat preferred by these species is limited in this watershed. The tailed frog lives in cold perennial streams and does not tolerate warm water temperatures. The Southern torrent salamander is a headwater specialist that prefers cool springs and seeps. Surveys are needed to determine if these species are present in the watershed and if there are concerns about the condition of their habitat.

Western pond turtle

The western pond turtle inhabits a wide range of fresh or brackish, permanent and intermittent water bodies from sea level to about 4,500 feet (1,372 meters). It is the only freshwater turtle native to most of the west coast of temperate North America (Stebbins 1966). Although western pond turtles are habitat generalists, hatchlings and juveniles have relatively specialized habitat requirements, and the microhabitats used by these age groups are often very limited and particularly susceptible to disturbance (Jennings et al. 1992).

Low fecundity, low hatchling and juvenile survivorship, high adult survivorship, and a potentially long life span characterizes the unique life history of the western pond turtle (Jennings et al. 1992). These turtles generally hibernate through the cold months. Activity begins in March, peaks in June and July, decreases gradually in August, increases briefly in September, and usually terminates in November. Some of the population leaves the watercourse in October and November and moves into adjacent upland habitats, and can overwinter several hundred meters from the watercourse. Dispersing turtles are vulnerable to certain human activities, especially when the turtles are moving slowly across roads. Females nest beyond the densely vegetated riparian zone (mainly from May to June), from 16 meters to 402 meters from the watercourse, and are particularly sensitive to noise disturbance at this time. Nests are usually on sunny south- or southwest-facing sites. Hatchlings overwinter in the nest, and move to the watercourse in early spring, usually March or April.

Turtles are often concentrated in lakes and ponds, and low-flow regions of rivers such as side channels and backwater areas. They prefer creeks that have deep, still water and sunny banks. Hatchlings are not much bigger in diameter than a quarter, and require shallow, edgewater areas with minimal currents. Adults concentrate in deep-water pools with lots of underwater debris. Western pond turtles rely on basking to maintain their body temperatures during the active season. Potential basking sites include protruding or floating woody debris, protruding rocks, emergent vegetation, overhanging vegetation that touches the water, and banks. Young turtles will also bask on algae or small surface debris (Reese 1993).

The western pond turtle feeds primarily on small aquatic invertebrates, but also on some small vertebrates and carrion. Many species are known to prey on the western pond turtle. Reasons for the decline of the western pond turtles and recruitment failures are numerous and complex, but the most important factors are alteration of aquatic and associated upland habitats, historical commercial exploitation, introduced predators,

habitat fragmentation leading to population fragmentation, and drought (Jennings et al. 1992). Livestock grazing can reduce terrestrial hiding cover, especially for juveniles.

Western pond turtles are found in a variety of streams and ponds in the Upper Main Eel watershed. The two lakes created by the Potter Valley Project created good adult habitat for western pond turtles, but safe juvenile habitat is limited throughout the watershed. The existing cool, high summer flows in the river between the two dams has disfavored western pond turtles. The greatest concentrations of western pond turtle habitat are at Lake Pillsbury and at the scattered ponds southeast of Lake Pillsbury. Adult western pond turtles have been seen throughout the watershed on low gradient stream reaches during fishery surveys. Surveys do not note the presence of juveniles on these streams. The small size of hatchlings and slightly larger juveniles makes them very difficult to locate. It is uncertain where successful recruitment might be occurring in the watershed.

Many exotic species have been introduced to the larger bodies of water and they are probably affecting survival of juvenile western pond turtles. Bass and bullfrogs are known to predate upon them, and Sacramento squawfish could be a problem as well.

Frogs

Red-legged and foothill yellow-legged frogs are both found in this watershed. The red-legged frogs in the Upper Main Eel watershed and some adjacent watersheds are a problem for taxonomists as they appear to be an intergrade between two different subspecies: northern red-legged and California red-legged frogs. However, both subspecies are rare and are in decline, so the taxonomic problems may be moot from an ecosystem management perspective. However, for regulatory reasons, it's important to note that the watershed is not listed within the range of the California red-legged frog which is proposed for listing under the Endangered Species Act.

Foothill yellow-legged and red-legged frogs have several similarities. They both spend the majority of their lives in or adjacent to the water, rarely venturing away from it (Zeiner, et al. 1990). They both metamorphose into adults within the year they are conceived. Tadpoles feed on algae and detritus and adults are mainly insectivorous. Different life stages have different needs and may use very different microhabitats. Individual adults of both species are believed to have very small home ranges. Both species could be impacted by changes to their breeding habitat and it has been shown that some types of fish enhancement structures can negatively impact frog breeding habitat (Fuller and Lind 1993). No breeding "hotspots" that would merit special projects or consideration in project planning have been located for either species, due to the lack of appropriate surveys.

Foothill yellow-legged frogs inhabit rocky, higher-gradient, shallow water-depth habitat. They require less vegetative streamside cover than red-legged frogs and often bask on exposed rocks. However, they do prefer streams with plenty of trees and canopy cover. Although they are occasionally found in overlapping habitats, it is believed that different microhabitat preferences probably reduce competition between them and red-legged frogs (Zeiner et al. 1990). Another difference is that foothill yellow-legged frogs breed in late spring to early summer, while red-legged frogs breed in late winter to early spring.

Red-legged frogs are more dependent on deep pools and slack water areas in stream habitat, marshes, and ponds (Zeiner et al. 1990). They require emergent vegetation in the water for breeding, and prefer riparian areas with extensive vegetation for general cover.

Recent fishery surveys report the presence of both species of frogs in the watershed. These surveys were not aimed at collecting specific frog information. The surveys give specific numbers found on some streams, but only note presence or absence on other streams. The surveyors did not distinguish between adults and subadults, nor were tadpoles identified.

The surveyors noted foothill yellow-legged frogs dispersed throughout most of the perennial streams in the Upper Main Eel watershed, although they were not common. They were not found along portions of the Upper Main Eel River and some tributaries. Foothill yellow-legged frogs were generally found in the higher gradient, canopied stream reaches. These streams are generally between third- and sixth-order streams.

Red-legged frogs were much more rare, being found in low numbers on just a few of the streams. Both the abundance noted, and the existing literature on these species, point out that the existing conditions in the Upper Main Eel watershed seem more favorable to maintaining populations of yellow-legged frogs.

Red-legged frog habitat in this watershed has probably been more impacted by past human alteration. The red-legged frogs' preference for lower gradient streams, deeper pools, and extensive vegetative cover made them vulnerable to the effects of human disturbance in this watershed. Grazing has been shown in several studies to have an effect on them, but this doesn't appear to be the sole limiting factor in most of the Upper Main Eel watershed. The cumulative effects of reservoir construction, water diversions, and other human and natural disturbances have altered stream flows and modified riparian habitat, which would have impacted their hiding and breeding habitat as well.

Another serious problem for the red-legged frogs in the Upper Main Eel watershed is introduced species, such as sunfish, and bullfrogs. They are present in many of the habitats that would have supported red-legged frogs. Safe red-legged frog habitat is limited in this watershed.

Worldwide amphibian research has linked amphibian declines with various toxicants, including acid rain and pesticides. Airborne pollution can stray far from its origin. We have no information concerning whether or not this is a problem in the Upper Main Eel watershed.

Willow Flycatcher

Willow flycatchers are insectivorous birds that specialize in the use of riparian habitat. They occupy relatively large wet meadows adjacent to large streams, and tend to nest in large clumps of willows separated by openings (Marcot 1979). Suitable areas for management of willow flycatchers include wet meadows measuring 0.62 acres or larger, and riparian areas of relatively open physiognomy with large patches of riparian deciduous shrubs (Fowler et al. 1991). While it is estimated that 2.2 acres of habitat is needed to support a pair of willow flycatchers and their young (Sanders and Flett 1989), the King River Conservation District (1985a) in the central part of Sierra Nevada Mountains, found that meadows as small as .50 acres have supported successfully breeding willow flycatchers.

Standing or flowing water, or saturated soils, are an apparent life requisite within the breeding territory of willow flycatchers (Fowler et al. 1991). Observations made by the Kings River Conservation District (1985b) and Sanders and Flett (1989) indicate that water does not need to be present during the later stages of reproduction, but is always present during pair formation.

Recent riparian studies along the Trinity River within the Shasta-Trinity National Forest have located three territories along the main stem of the Trinity River, generally at the confluence of major tributaries. These sites were deltaic riparian areas, rather than the large wet meadows more commonly utilized. The common denominator appears to be that they prefer broad riparian areas containing dense willows thickets, yet containing openings in those thickets, and presumably abundant insects. Variations in habitat preference are possible.

The willow flycatcher was formerly a common summer resident throughout California. Most of the known population today is located in the Sierra Nevada and along the Kern, Santa Margarita and San Luis Rey Rivers (Sanders and Flett 1989), but birds have been located on the McCloud and Trinity Districts on the Shasta-Trinity and Six Rivers National Forests. There is a 1981 sighting report for in this watershed from near Lake

Pillsbury (Lindly pers. comm). This sighting was part of the breeding bird survey done by the Audubon Society.

Zeiner, et al. (1990) blamed parasitization by brown-headed cowbirds and habitat alteration for the decline of the willow flycatcher throughout California. Cowbirds are found throughout California, but their abundance in this watershed is unknown. It is not expected that the watershed contains numerous breeding pairs under the current conditions.

Limited parts of the Upper Main Eel watershed, such as the riparian areas adjacent to Lake Pillsbury and just downstream of Scott Dam, have the potential for growing dense stands of willows and could potentially support willow flycatchers. Much of this habitat is on private land. However, the majority of known territories in northern California are not located in areas of high recreational use, such as occurs around Lake Pillsbury. Other potential habitat exists higher in the watershed at smaller meadow sites.

Although few willow flycatchers are known to be breeding in California, researchers have found many of them in the Klamath and Sacramento River basins during the summer. The numbers peak in August to September according to Forest Service Pacific Southwest Experiment Station bird researcher C.J. Ralph (pers. comm.). The birds are located via mist-netting, as they are not very vocal post-breeding. The birds feed in these areas on their way south after breeding. They have been found at lower elevations adjacent to the Klamath and Sacramento Rivers, but not on river tributaries. Their habitat preference and usage at this time of the year is not fully understood, nor is their distribution known. It is likely that such migrants would use appropriate habitat around and between Lakes Pillsbury and Van Arsdale and that such use is an important part of their life history.

Serena (1982) suggested that small populations, (e.g. single breeding pairs), will die out more frequently than larger populations, and small population sites will be recolonized very slowly (especially given the present rarity of willow flycatchers). Developing or maintaining suitable habitat across the watershed is important to provide opportunities for this species to recolonize their former range.

A potential conflict in the Upper Main Eel watershed is that cattle, when grazing in riparian areas, often modify willow thickets to disfavor these birds. Willow flycatchers need dense willow thickets for nesting and roosting. Livestock tend to eat young willows and hedge the older ones, creating sites that don't meet the needs of the flycatchers. Also, cattle can directly impact willow flycatchers by knocking over their nests. Willow flycatchers usually place their nests near the edge of willow clumps (which may be along livestock trails), making them vulnerable to disturbance by cattle (Sanders and Flett 1989).

For these reasons, the Mendocino National Forest is proposing a limited operating period for cattle grazing to protect the willow flycatcher and their nestlings from July 1 to August 15 wherever breeding pairs are found. Allotments that have potential willow flycatcher habitat will have an aerial photo review and subsequent field review to determine if there is potential habitat available for the flycatcher.

Bats

Four species of bats listed in Table C-3 of the ROD and Appendix J2 of the FSEIS ROD are believed to inhabit the Upper Main Eel watershed and are dependent on riparian areas; they are the long-eared myotis, fringed myotis, long-legged myotis, and silver-haired bat. The pallid bat is also listed in Table C-3 and Appendix J2, but according to Zeiner, et al. (1990) the pallid bat is not significantly associated with riparian habitat. No surveys have been conducted for any of these species in this watershed.

All of these species forage for insects over assorted habitats including wet meadows and water (Zeiner, et al. 1990). They are important ecologically since they eat numerous insects over riparian areas and disperse their guano (full of important nutrients) away from the riparian zones. Lake Pillsbury, the scattered ponds in

the Upper Main Eel watershed, and the larger streams in the watershed should be especially attractive to many of these bats for feeding locations. Several species also prefer foraging over early successional habitat or the ecotones between disturbed and undisturbed habitat. Bats are known to fly considerable distances to forage, but areas deficient in available roosting habitat, such as large brushfields, probably receive little utilization. All four species appear to prefer foraging over, and roosting in, forest habitat, rather than chaparral habitat.

Bats spend their days in assorted roosting locations, but tree cavities, snags, and loose bark associated with older trees are probably the predominant natural locations in the Upper Main Eel watershed. Several species prefer caves for roosting, but caves are not abundant in this watershed. Human structures are more prevalent, especially around Lake Pillsbury, and those are probably utilized as well. It should be noted that repeated disturbance/awakening of bats at their winter hibernation sites will result in their death.

Habitat and current management in the Upper Main Eel watershed appears to provide reasonable habitat for these four species, according to a review of the literature. Mitigation measures for project activities can be found in Appendix J2 of the FSEIS. These four bat species may be impacted by pesticide residues in insects due to off-Forest pesticide use, since both bats and their prey have the ability to disperse widely.

4.6 Future Trends

Riparian Habitat

Discussion of the Aquatic Conservation Strategy and its objectives is found on pages B-9 through B-34 of the ROD. This strategy guides future management toward approximating natural disturbance processes and and conditions. Land-use activities that retard or prevent attainment of ACS objectives need to be modified. The ROD directs that National Forest System land within this watershed be managed to maintain and restore the health of the watershed.

Natural processes such as fire and flood will continue, but they will be impacted by human management. Human impacts will vary according to the actual practices employed; our actions could soften, increase, or have no effect on the impacts of natural disasters.

Future fuel treatments are expected to reduce the size and intensity of fires and their impacts on riparian values. Future prescriptions are expected to balance the need to manage fuel load with the side effects of the treatments.

Grazing in accordance with ROD standards and guidelines is not expected to have significant impacts on most riparian values or attainment of ACS objectives. Monitoring is expected to provide information as to whether the new standards are effective, and when adjustments are needed, until site-specific allotment planning is completed. Close coordination and cooperation between the Upper Lake and Stonyford Ranger Districts in monitoring and enforcing standards should assure ACS objectives are met along their shared boundaries.

The most difficult challenge may be in regulating grazing to meet the needs of certain riparian-dependent species of concern. Straying of cattle into headwater riparian areas near Bald Mountain may continue, and straying may potentially occur in other parts of the watershed. However, livestock straying is not expected to conflict with riparian values in the majority of riparian zones.

Riparian habitat is expected to generally improve in the future throughout Forest Service lands within the Upper Main Eel watershed, through adherence to ROD standards and guidelines. Most ACS objectives are expected to be generally met throughout most subwatersheds. However, some ACS objectives seem difficult to attain and this will limit the extent of improvement of riparian health. Extensive planning and management

actions will be required to decrease erosion and peak flows. A transportation plan that better meets ACS objectives would probably provide fewer miles of vehicular access than now exist in most subwatersheds.

The size and condition of the existing road system is at odds with the goal of approximating the "natural" disturbance regime, including peak flows and erosion. The existing budget does not allow the Forest to provide for appropriate maintenance of Forest roads. Many roads, stream crossings, and culverts are in need of repair to limit chronic, ongoing sediment problems, or to prevent future failure. Periodic maintenance will be needed for as long as these roads are in place. Emergency storm-damage money is one source of additional money to deal with failure problems. However, this money does not prevent the erosion that comes from the initial storm damage, and normally allows only replacement-in-kind rather than upgrade or correction.

Certain subwatersheds have high road densities that are contributing to peak flows and erosion. Decommissioning some of these roads would be an appropriate way to deal with this problem, except most roads are in place because access is thought necessary for some resource management activity or because of public use.

An additional projected challenge is related to the proposed 100-year rotation harvest of matrix lands within this watershed. Meeting this expectation might result in keeping many existing roads open and creating new ones where necessary.

These limitations to the attainment of ACS objectives are not expected to be overcome without new transportation planning, an increase in the use of logging systems not dependent on extensive road access, and funding sufficient to meet the needs of maintenance and/or decommissioning. See Sections 10.6 and 11.2 for additional discussion of this subject.

Riparian-Dependent Species of Concern

Although riparian habitat is expected to improve, the riparian-dependent species of concern are not expected to significantly increase in numbers in the near future without special management actions by different agencies. Future inventories may identify specific habitat projects that would benefit these species (see Section 11.1). Locating, maintaining, and enhancing good breeding and rearing habitat is important to support well-distributed populations of red-legged frogs and western pond turtles in this watershed. Management of frog and turtle habitat to increase recruitment would probably be most effective in and around the small ponds of this watershed; trying to improve habitat along the margins of Lake Pillsbury would likely be effective as well.

However, Forest Service stewards may not always be able to affect the factors that are most impacting these species, especially with birds and bats that range far from the Forest. Some problems are controlled by other agencies or the problems originate off-Forest. Competition and predation by introduced species such as sunfish, bullfrogs, and *P. grandis* are expected to continue unless the state undertakes projects to eliminate the exotics. If airborne pollution from outside of the watershed is affecting frogs or other species in the Upper Main Eel watershed, this would not be modified by following the ROD standards and guidelines.

Bass and other sunfish are expected to continue to predate upon native species in Lake Pillsbury, the Upper Main Eel River, and the lower portions of their tributaries. Assuming that the state does chemically eliminate exotic, unwanted fish species from Lake Pillsbury, it is likely that bass and other sunfish will be reintroduced. Bass and other sunfish may be reintroduced by the state or private parties to provide fishing opportunities. Unauthorized movement of fish by private parties will likely continue.

Unauthorized movement of non-native aquatic vegetation into Lake Pillsbury from Clear Lake or elsewhere would affect the aquatic community structure in Lake Pillsbury. It is uncertain how native turtles or frogs would be affected by such an action.

5.0 ISSUE 3--THREATENED, ENDANGERED AND SPECIAL STATUS SPECIES

5.1 Issue Statement

Concern exists over habitat distribution patterns and relative abundance of threatened, endangered, and special status (TE&S) animal and plant species in the Upper Main Eel watershed and their contribution toward species dispersal, viability and diversity. Naturally diverse conditions and processes combined with past management actions have created concern over habitat loss, fragmentation, spatial and temporal distribution, and connectivity. This could threaten immigration, emigration, and reproductive capabilities of local populations of threatened, endangered, and special status species. Special status species include Forest Service designated sensitive and management indicator species, neotropical migrant birds, and the survey and manage species under the Record of Decision, Attachment C, Table C-3.

5.2 Desired Conditions

Habitat and its components provide for all life history needs in order to support viable populations of threatened, endangered and special status species.

Dispersal habitat is maintained within this watershed and between adjacent watersheds for threatened, endangered, and special status species.

Late successional reserves are functioning as designed, and management activities along with appropriate monitoring help maintain their ecological function through time.

Activities associated with Lake Pillsbury meet the requirements of the Recovery Plan for the Pacific Bald Eagle and the Bald Eagle Habitat Management Plan for Lake Pillsbury.

5.3 Key Questions

What are the roles of this watershed and of riparian areas in particular in the distribution of TE&S species and habitat connectivity? (See Sections 5.5 and 5.6.)

What are the current and historic habitat conditions for TE&S species in the watershed? (See Sections 5.4 and 5.5.)

What are the current and historic population levels and distribution of TE&S species in the watershed? (See Sections 5.4 and 5.5.)

Are there barriers to movement of TE&S species within and between watersheds? Are they natural? If not, what can be done to change the present situation? (See Section 5.5.)

What level of management activities is compatible with the maintenance of habitat needed for TE&S species? (See Section 4.6 and Chapters 5, 10, 11, and 12.)

Are habitats or their components present which will provide the required life history needs of TE&S species? How well distributed are they and what is their condition? What opportunities exist to provide these habitats or components if they are not present? (See Sections 5.5 and 13.2.)

What are the current and historic, natural and human disturbance regimes and how have they affected present habitat conditions and wildlife populations? (See Sections 5.4 and 5.5.)

What are the impacts and scale of management activities on TE&S species? (See Sections 5.4, 5.5 and 5.6.)

What TE&S plant species are found in this watershed, and what are their habitat requirements? (See Section 5.5.)

5.4 Past Conditions and Processes

Some limited information on historical conditions in the Upper Main Eel watershed has been documented (Supernowicz 1995). Information on wildlife is limited to those species that were utilized by humans or interfered with the human activities of the time. For the most part accounts record deer, grizzly bear, black bear, mountain lion, and coyote populations. It is difficult to assess from these records the extent of forested habitats, their condition, and their locations.

Old-Forest Dependent Species

For this analysis the northern spotted owl will serve to represent old-forest related species. (The wildlife biologists contributing to this chapter prefer to use the term "old-forest," which encompasses all required habitat characteristics, while "old-growth" refers only to the size and age of trees). It is apparent that the habitat within the watershed has been influenced by human activities for centuries. To what extent these activities affected late-successional forests and the species that inhabited them is not known. More information is needed regarding these species (see Section 13.2).

Fire history in the Upper Main Eel watershed shows a past pattern of large frequently occurring fires. Fire appears to have contributed in the past to large-scale disturbances within this watershed and is likely to have contributed to fragmentation and loss of forested habitats to an extent that would have affected northern spotted owls.

Information on northern spotted owls was first gathered in the early 1970s, and this information was limited. Because of this lack of historical information, this species is addressed in more detail in the Current Conditions and Processes section in this chapter, Section 5.5.

Marbled Murrelet

This watershed does not contain any management zone 1 or zone 2 for the marbled murrelet, nor does it provide any habitat for the marbled murrelet. Therefore, this species will not be discussed in this document.

Bald Eagles

There is no information on bald eagle presence in this watershed prior to the construction of Scott Dam in 1921, and there is no documentation of bald eagle activities from 1921 to 1967.

While bald eagle nesting records were not kept until 1967, it has been reported that bald eagles were nesting in the Lake Pillsbury area prior to 1935 (Jenkins 1988).

There are many processes that could have affected bald eagles in this watershed. These include, but are not limited to, vegetation changes and the use of DDT and other organochlorine pesticides. Vegetation changes that have affected bald eagles in this watershed have been the result of fires, logging, and recreational developments (see Chapter 9). It is not known how these events have affected the bald eagles. The creation of Scott Dam may have benefited bald eagles by creating a stable food source for them in this watershed.

DDT and other organochlorine pesticides have been linked to eggshell thinning, which causes a decrease in reproductive success among raptors. It was due to the nationwide correlation of eggshell thinning and increased levels of DDE (a metabolite of DDT) that the use of DDT was banned in the early 1970s. In 1984 and 1987 eggshell fragments and abandoned eggs from Lake Pillsbury were sent in for pesticide testing. The lab reports for 1984 found a DDE level of 4.5 ppm (wet) and an eggshell thinning of 6 percent. Fish samples from Lake Pillsbury were sent to the California Department of Fish and Game Lab, but no DDE was found.

Peregrine Falcons

One historical nesting site for peregrine falcons was located at the current site of Lake Pillsbury. The cliff was destroyed and thought to have either been removed for dam building material or used as a part of the dam (USDA 1978).

Processes that have affected peregrine falcons include the use of pesticides such as DDT and other organochlorine pesticides, natural weathering of ledges used for nesting (USDA 1978), and indirect effects on their prey base. DDT is attributed as the cause for eggshell thinning in peregrine falcons. Natural weathering has caused several historic nesting ledges on the Forest to crumble and become unsuitable for peregrine falcon nesting. Additionally, during the late 1970s these sites were being utilized by prairie falcons, which can nest on smaller ledges. An indirect effect on peregrine falcons has been the effect that management activities and natural disturbances have had on avian habitats. When avian prey habitat was degraded, populations may have decreased, and this may have negatively affected peregrine falcons.

TE&S Plants

Historical information on threatened, endangered, and sensitive plants has been limited, and generally includes only species type and general location. Because of this, the information is limited in its usefulness.

The historical processes that have affected threatened, endangered, and sensitive plants are grazing, natural disturbance events (fire, slides, etc.), management activities, and fire exclusion.

Management Indicator Species and Neotropical Migrant Birds

There is no past population information on management indicator species or neotropical migrant birds in this watershed.

Attachment C of Table C-3 Species

See Section 16.4 for a list of species that have the potential to occur in this watershed. Information about these species is limited at this time to that provided by the literature identifying potential habitat or distribution. These species will not be discussed further in this chapter.

5.5 Current Conditions and Processes

Old-Forest Dependent Species

Collection of data on wildlife species on the Mendocino National Forest has been limited to monitoring of threatened and endangered species for compliance with Section 7 of the Endangered Species Act (ESA), and research, development and application (RD&A) inventories. Data collected have included information on

species presence, and on reproduction when possible. The present analysis is limited by this lack of data and caution should be used when interpreting these data to determine future management activities.

The earliest records of spotted owls in this watershed are from the early 1970s. These sightings are incidental and often without maps, leaving the information limited in its usefulness. Information on spotted owl locations increased and became increasingly accurate in the late 1980s.

Currently there are 33 activity centers in the watershed. This is the number of activity centers identified to date based on data in the Mendocino National Forest Supervisor's Office. The Forest is still in the process of verifying all spotted owl information, and mapping owl sightings and designating activity centers. Activity centers are locations of owl pairs or territorial single owls. Territorial single owls are defined as a single owl detected on three different outings in one or more years. Activity centers do not include locations of single non-territorial owls. Caution must also be used in interpreting these data because only some areas within the watershed have been surveyed. In those areas only sites of proposed timber sales or projects have been surveyed in recent years. Late successional reserves (LSRs) RC311, and parts of RC313 and RC312, were surveyed during 1991 while they were designated as habitat conservation areas (HCAs). In 1992, LSRs RC311, RC312, and part of RC313 were also surveyed under the HCA designation. (LSR RC313 was formed when HCA 21 and HCA 22 were combined in 1994.)

Table 5-1 shows the distribution of owl activity centers by ROD land allocation. Of the 33 activity centers in this watershed, 26 have pair status and the remaining 7 are territorial single birds. The owls in the LSRs are divided into those occurring inside the watershed and those occurring outside the watershed boundary. There are six activity centers located in the matrix, or possibly riparian reserves (5 pairs and 1 territorial single). Each activity center that is not protected by an LSR, congressionally withdrawn area, or riparian reserve is provided with a 100-acre core area which is then managed as an unmapped LSR. (Mapped LSRs are those that are shown on the Alternative 9 map that was included with the final SEIS, and unmapped LSRs are the 100-acre core areas around spotted owl activity centers located in matrix lands.)

These activity centers include pairs and territorial singles and are distributed throughout the watershed. They appear to be most prevalent in mixed conifer and mixed conifer/hardwood forests with greater than 60 percent canopy closure, located for the most part on the lower third of the slope. This is consistent with the findings of Thomas et al. (1990). While correlation with habitat can be made for spotted owl nesting habitat, it is not known what stand attributes and habitat features are important for territorial single owls on the Forest. It is also not known what habitat conditions and stand attributes existing in the surrounding area are selected for foraging and dispersal.

Documentation of reproduction was extremely limited prior to 1989. The data that have been collected in this watershed are limited in their usefulness due to the restricted nature of survey efforts and the type of data collected. Of the 26 owl pairs known to inhabit the watershed, 13 have been known to reproduce since 1989. Of these 13 pairs, only 3 are known to have reproduced in consecutive years. Data are not available to determine what conditions are required for reproductive success within this area. Since 1989, 13 pairs are not known to have reproduced in this watershed. (These birds may have reproduced during this time. Either surveys found that they were not nesting, or those areas were not surveyed during those years.) There is one territorial single female, and six territorial single males in the watershed. The availability of single female birds appears low for this Forest (perhaps due to survey bias). Non-territorial single owls ("floaters") show a strong skew toward males.

Table 5-1. OWL ACTIVITY CENTERS IN LSRs, WILDERNESS, AND MATRIX

	Inside Watershed Boundary		Outside Watershed Boundary		Wilderness and LSR Totals	
	Pairs	Territorial Singles	Pairs	Territorial Singles	Pairs	Territorial Singles
LSR RC311	8	2	0	0	8	2
LSR RC312	6	3	0	0	6	3
LSR RC313	4	0	2	2	6	2
LSR RC315	3	0	4	0	7	0
Wilderness	0	1	1	1	1	2
Matrix	5	1				
Totals	26	7	7	3	28	9

There are six activity centers in this watershed outside of LSRs and wilderness, and none of these occur south of township 19N. It is not currently known what has caused this condition, but several potential reasons exist. These include but may not be limited to: juvenile mortality while dispersing due to a lack of dispersal habitat, a lack of suitable habitat for owls to establish territories, and gaps between areas that have been surveyed where there may have been pairs or territorial single birds that were not found. In addition, the low number of territorial single owls in this watershed may indicate a downward population trend or a lack of habitat.

Nesting and roosting habitat have been defined as being the same for this Forest. Nesting and roosting habitat is currently defined as being M4G and M6G vegetation types. (The Forest combined M4G, M4N, M5N, and M5G timber types to create the M4G timber strata, which is the vegetation information in the Forest GIS system.) Additional nesting and roosting may occur in this watershed in other vegetation types which have not yet been identified. Not all M4G vegetation contains the habitat characteristics that contribute to suitable nesting habitat. This could be verified at the site-specific level if needed. There are 19,802 acres of nesting and roosting habitat in this watershed, approximately 9 percent of the federal land within the watershed (Table 5-2).

Table 5-2. ACRES OF SUITABLE NESTING AND ROOSTING HABITAT BY LAND ALLOCATION

Land Allocation Within This Watershed	Acres of M4G, M6G Vegetation
LSR RC311	7,011
LSR RC312	2,546
LSR RC313	2,430
LSR RC315	2,222
Wilderness	1,006
Riparian Reserves	2,810
Matrix	1,775
RNA	0
RNA in LSR RC313	7

Certain assumptions were made to determine the amount of dispersal habitat that was greater than or equal to 11 inches DBH, and greater than or equal to 40 percent crown closure ("11/40"). Vegetation that did not meet or exceed 11/40 in 1979, when the vegetation was mapped, was not included; only vegetation that was thought to meet 11/40 was included; vegetation types included M3G, M4G, M6G, and C4X (Table 5-3). The Proposed Forest LRMP includes a percentage of M2G timber strata that is believed to meet 11/40, based on sampling information. While this would be appropriate at the Forest scale, it is not appropriate at the smaller watershed scale, which is more site specific. Also, not all C4X vegetation type provides dispersal habitat, but it is generally considered to meet the definition. This could be verified at the site-specific level if necessary. As a result of these assumptions and calculation methods, there may be additional areas that meet 11/40 or serve as dispersal habitat that were not identified, and the acreages may be underestimated. Given these assumptions, however, it is estimated that 18 percent (41,191 acres) of the federally owned lands within this watershed meet or exceed 11/40.

Table 5-3. ACRES OF SUITABLE DISPERSAL HABITAT BY LAND ALLOCATION

Land Allocation Within this Watershed	Acres of M3G, M4G, M6G, C4X Vegetation
LSR RC311	13,462
LSR RC312	4,556
LSR RC313	3,180
LSR RC315	3,038
Wilderness	2,173
Riparian Reserves	8,843
Matrix	5,938
RNA outside LSR RC313	1

Current conditions have increased the potential for large-scale disturbance events that could increase habitat fragmentation and have a negative impact on northern spotted owls.

Patterns of natural vegetation, drainage patterns, random environmental disturbances and recent timber management patterns have most likely contributed to the current distribution of owls within the watershed.

Another process that has the potential to affect northern spotted owls is use of the current OHV trail system. Use of those trails that pass within 0.25 miles of nesting owls have the potential to disrupt their reproductive activities. There are opportunities in this watershed to determine if OHV trail use near nesting spotted owls is detrimental to successful reproduction (see Section 14.2).

See Section 16.3 for further discussion of questions found in the FY 1994-96 Watershed Analysis Guidelines.

Currently, trapping records and incidental sighting records are the only information available on fur-bearers in this watershed.

Bald Eagles

Bald eagle nesting territories are usually associated with lakes, reservoirs, rivers, or large streams. Wintering habitat is associated with large bodies of water and is limited on the Forest. Bald eagle nests are usually located in uneven-aged, multi-storied stands with old growth components (Anthony et al. 1982). The nests at Lake Pillsbury are located in predominantly coniferous stands. Factors such as relative tree height, diameter, tree species, position on the surrounding topography, distance from water, and distance from disturbance also appear to influence nest site location (Lehman et al. 1980).

Trees selected for nesting are characteristically dominant in the stand or at least co-dominant with the overstory. Nest trees usually provide an unobstructed view of the associated body of water and are often dominantly located on the topography. Live, mature trees with deformed tops are occasionally selected for

nesting. Of the nest trees identified in California, about 71 percent were ponderosa pine, 16 percent were sugar pine, and 5 percent were incense cedar. The remaining were distributed among five other coniferous species. Potential nest trees are defined as being 41 to 46 inches diameter at breast height and in excess of 100 feet tall (Lehman et al. 1980).

In California, 73 percent of nest sites were found within 0.5 miles of a body of water, and 89 percent within 1.0 miles. No nests were found greater than 2.0 miles from water (Lehman et al. 1980).

Bald eagles often construct several nests within a territory and alternate between them from year to year. Up to five alternate nests have been found in a single territory (USDI Fish and Wildlife Service 1986).

Snags, trees with lateral exposed limbs, or trees with dead tops are often found in nesting territories and are used as perches or as points of access to and from the nest. These trees also provide vantage points from which territories can be guarded and protected.

Adults generally arrive around the first of the year and fledge young by the end of August. Critical times of disturbance for the bald eagle are between January and late May. The effects of nest disturbance decrease as young mature.

Bald eagles are predatory-scavengers that predominantly feed on a variety of fishes. Jenkins (1988) documented that bald eagles at Lake Pillsbury consume *P. grandis* and Sacramento suckers as their primary prey, and this accounted for 50 percent of the biomass consumed; bird species represented 8.1 percent of the prey consumed. Mammalian food items represented 14 percent of the prey consumed; however, this value is likely skewed due to the size of the prey species involved. Mammalian prey does not appear to be of significance in the diet of the Lake Pillsbury bald eagles.

A pair of bald eagles has been documented at Lake Pillsbury since 1967. A bald eagle nest has been known to be active for 21 of those 27 years. In two of the 21 years the nest was abandoned. In 1970 and 1989, nesting activity was unknown. Of the years of active nesting, 12 years were successful and produced 20 young that fledged. In 1967, 1987, and 1993 when the nest was active, no young were fledged. The cause of nesting failure in this watershed has not been determined. Also in 1992 when the nest was active, it is unknown how many young fledged, but one young was observed in the nest (Table 5-4). Prior to 1995 there was only one known nesting pair of bald eagles on the Forest. The only time prior to 1995 that the Lake had more than one pair of bald eagles was in 1987. It was thought there were two eagle pairs there that year due to the presence of fish traps set for *P. grandis*. The first surveys conducted this year (1995) have shown that there are more eagles using the lake and its tributaries than have ever been documented in the past. The surveys have identified two occupied nesting territories, one potentially occupied nesting territory, and two sub-adults utilizing the lake and its tributaries. It is not known if this was caused by previous survey error, or if more eagles started utilizing the area this year.

Current processes that have the potential for affecting bald eagles include the threat of disturbance events and recreational use of the Lake Pillsbury area. Recreational use of the area is discussed in Chapter 9. Disturbance events, which include fire, insects, and disease, have the potential to destroy habitat needed by the bald eagles for successful reproduction.

Table 5-4. BALD EAGLE REPRODUCTION AT LAKE PILLSBURY

YEAR	Number of Young Fledged	Nest Active?
1967	0	Yes
1970	unknown	unknown
1971	2	Yes
1972	unknown	Yes
1973	0	No
1974	1	Yes
1975	1	Yes
1976	0	No
1977	2	Yes
1978	2	Yes
1979	0	No
1980	0	No
1981	2	Yes
1982	2	Yes
1983	0	abandoned
1984	0	abandoned
1985	2	Yes
1986	1	Yes
1987	0	Yes
1988	2	Yes
1989	unknown	unknown
1990	2	Yes
1991	unknown	Yes
1992	unknown	Yes

Table 5-4. BALD EAGLE REPRODUCTION AT LAKE PILLSBURY (continued)

YEAR	Number of Young Fledged	Nest Active?
1993	0	Yes
1994	1	Yes
1995	too early	Yes

Peregrine Falcons

Peregrine falcons have relatively strict nesting requirements. They prefer vertical cliffs with large potholes or ledges that are inaccessible to land predators and that are located near habitat that has a large avian prey population such as wetlands or waterways. Their diet consists almost entirely of birds (Bent 1983, Herbert and Herbert 1965); however, peregrines have also been known to take small mammals (Kirvin 1978, Monk 1981) and fish.

Adult breeding pairs establish or re-establish their territories between late February and early April. The following information regarding observations of young is provided because they appear to have hatched earlier than some current literature indicates they should be hatching, and this may influence the timing of surveys when active eyries are found in this watershed. Twenty-day-old peregrine falcon young were observed on the Forest on 1 June 1993, and the young were aged using the 1983 photographic guide for nesting prairie falcons (M. Ramsey pers. comm.). Additionally, 24- to 27-day-old young were observed on 1 June 1994, and 21- to 23-day-old young were observed on 22 May 1992 on the Forest and aged with the same method above (C. Keckler pers. comm.). Fledglings remain at the nest site until early fall when they disperse. Some adults remain loosely attached to their territories throughout the year and others migrate.

While there have not been nesting falcons located within the watershed, there have been several sightings around the Lake Pillsbury area and the Eel River. The Lake Pillsbury area is thought to be a winter foraging area for the falcons. There are anecdotal accounts of an eyrie outside of the Forest boundary near this watershed.

Current processes that affect peregrine falcons in this watershed include nest enhancement projects (2 ledges and 1 box), disturbance, and natural weathering of ledges. The three enhanced nest sites are not yet known to have been utilized for nesting. Noise and visual disturbance have the potential to interrupt peregrine falcon reproductive activities at any active eyrie. There are also indirect effects caused by alteration of habitat or populations of prey species.

TE&S Plants

The following are TE&S plants that have the potential or are known to occur in this watershed (USDA 1994), along with habitat descriptions and associated species. Water Howellia and Snow Mountain buckwheat have the potential to occur in this watershed, and the remainder of the species listed are known to occur in this watershed.

Scabrid raillardella (*Raillardiopsis scabrida*) is found on rock outcrops and scree slopes of mountain peaks in an open sub-alpine type of vegetation. It is most common on the tops and leeward slopes of hogback ridges within 25 meters of the ridge top. Occasionally it is found in the protected ravines and drainages of the slopes.

Associated species include wild onion (*Allium falcifolium*), rabbit brush (*Chrysothamnus nauseosus* ssp. *albicaulis*), squirreltail (*Elymus elymoides*), sulfur flower (*Eriogonium umbellatum* var. *furcosum*), mountain golden brush (*Haplopappus greenei*), oceanspray (*Holodiscus discolor*), lomatium (*Lomatium macrocarpum*), sandwort (*Minuartia nuttallii* spp. *gregaria*) and Snow Mountain beardtongue (*Penstemon purpussii*).

Anthony Peak lupine (*Lupinus antoninus*) is found to grow on rocky outcrops and dry talus and shaley slopes on mountain tops above timber line. No associated species are listed.

Stebbin's lewisia (*Lewisia stebbinsii*) grows in dry, exposed, gravelly flats amidst volcanic rock and rubble, adjacent to sparse Jeffery pine/white fir forest. It has recently been found to grow among brewer oak. Vegetation is sparse, mostly consisting of herbaceous perennials that die back in the fall. The most favorable habitat is on northwest- to northeast-facing slopes. Associated species include white fir (*Abies concolor*), wild onion (*Allium falcifolium*), sagebrush (*Artemisia* sp.), pussypaws (*Calyptridium umbellatum*), fleabane daisy (*Erigeron lassenianus*), horkelia (*Horkelia tridentata* spp. *flavescens*), lewisia (*Lewisia nevadensis*), phoenicaulis (*Phoencaulis cheiranthoides*), Jeffrey pine (*Pinus jeffreyi*), brewer oak (*Quercus garryanna* var. *breweri*), Douglas violet (*Viola douglasii*) and violet (*V. hallii*).

Cleveland's milkvetch (*Astragalus clevelandii*) occurs in serpentine seeps and on sandy banks of streams, chiefly on serpentine soils. Associated species include viscid manzanita (*Arctostaphylos viscida*), leather oak (*Quercus durata*), western azalea (*Rhododendron occidentae*), willow (*Salix* sp.) and California bay (*Umbellularia californica*).

Glandular dwarf flax (*Hesperolinon adenophyllum*) occurs in serpentine grasslands and grassy openings of serpentine chaparral. In some areas individuals occur between patches of serpentine chaparral in an area that is entirely composed of herbaceous plants, including soft brome (*Bromus hordeaceus*), calycadenia (*Calycadenia pauciflora*), and big squirreltail (*Elymus multisetus*). Other plant associates include white-leaf manzanita (*Arctostaphylos viscida*), Jepson's ceanothus (*Ceanothus jepsonii* var. *albiflorus*) and leather oak (*Querus durata*).

Drymaria-like dwarf flax (*Hesperolinon drymarioides*) occurs in openings of serpentine grey pine-chaparral, northern interior cypress forest and mixed serpentine chaparral. Plant associates include white-leaf manzanita (*Arctostaphylos viscida*), McNab cypress (*Cupressus macnabiana*), Sargent's cypress (*Cupressus sargentii*), grey pine (*Pinus sabiniana*) and leather oak (*Quercus durata*). Plants are generally clustered in groups of 1-10 in openings between trees and shrubs in dark red serpentine soil of the Henneke soil series. Populations having high densities (5-20 plants per square meter) are mostly in areas that have been naturally disturbed, such as by tree falls or fires.

Snow Mountain willowherb (*Epilobium nivium*) grows in crevices of rocky outcrops and dry talus and shaley slopes on mountain tops, typically with a southern exposure. It is also found on rock outcrops all the way down into the montane chaparral and mixed conifer type. Associated species include white fir (*Abies concolor*), manzanita (*Arctostaphylos canescens*), greenleaf manzanita (*A. patula*), silk tassel (*Garrya fremontii*), oceanspray (*Holodiscus discolor*), Jeffrey pine (*Pinus jeffreyi*), canyon live oak (*Quercus garryana*) and black oak (*Q. kelloggii*).

Snow Mountain buckwheat (*Erigonum nervulosum*) is not found in this watershed, but has been found adjacent to it, and is included here because it has a higher potential of occurrence in this watershed than others. This species is primarily restricted to barren serpentine outcrops and slopes, where it often grows on the less steep bases or ridgetops of the barrens. It also grows on serpentine strata on exposed rocky flats and slopes or in the crevices of outcrops at the higher elevations (1,980-2,100 m). An associated species is Greene's buckwheat (*Erigonum strictum* var. *greenei*), which has been found growing with it. Serpentine associates include wild onion (*Allium falcifolium*), Socrates Mine jewelflower (*Streptanthus brachiatus*), and Morrison's jewelflower (*S. morrisonii*). *E. nervulosom* does not, however, grow directly with these species.

Water Howellia (*Howellia aquatillis*) does not have any known sites currently in California; however, due to a 1928 sighting on this forest, current listing as federally threatened, and potential habitat within this watershed, it is included in this analysis. *H. aquitillis* is an aquatic species that is restricted to the quiet water of retired oxbow sloughs and glacially formed pothole ponds and shallow lakes that dry out substantially by the end of each growing season. Associated species may include foxtail (*Callitriche heterophylla*), spikerush (*Eleocharis macrostachya*), and buttercup (*Ranunculus aquatilis* and *R. reptans*).

Current processes that have the potential to affect the TE&S plants in this watershed are primarily those associated with management activities, including: logging; geothermal energy development; road grading, expansion, and development; grazing; off-highway vehicle use and trail development; fire suppression and controlled use; and natural disturbance events. These activities have the potential to damage or eliminate known populations, or to destroy undocumented populations. Therefore, caution should be utilized when these activities are undertaken.

Management Indicator Species

This discussion of current conditions is limited to that of habitat conditions for early successional species. The last large fire which would have created a large amount of habitat for early successional species in this watershed occurred in 1987. The burned area is now eight years old and is decreasing in production of suitable and palatable browse (J. Booth pers. comm.). There are restoration projects that could be pursued in this watershed to assure additional habitat for these species on an annual basis; these are discussed in Section 11.2. Partnership opportunities also exist, and some of these are identified in Section 12.1. Needed information is discussed in Section 13.2

5.6 Future Trends

Old-Forest Dependent Species

In order to analyze condition trends and assess the potential effects of management within this watershed, an understanding of conservation biology and population ecology is necessary. To maintain viable populations of old forest species in this watershed and throughout the Forest, it is important that habitat and its components are maintained. Deleterious fragmentation of the landscape from management activities and natural events must be minimized.

Island-biogeography theory was initially developed by MacArther and Wilson in 1967 (Terborgh and Winter 1980) and demonstrated that extinction is strongly area dependent. Extinction-prone species are often those with large body size that are habitat specialists. Causes for extinction in habitat islands (defined as disjunct patches of vegetation surrounded by vegetation of a different kind) are divided into primary and secondary causes.

Primary causes are fragmentation, negative population growth, and dependence on irregular resources. Such causes are due to reductions in population size and occur mainly among large or nomadic species and those that are habitat specialists.

Secondary causes are alteration of interaction webs, especially predator-prey and pollinator-disperser relationships, and secondary or tertiary loss of food plants or prey species due to the combined effects of all of the above (Treborgh and Winter 1980). These are due to ecological imbalances resulting from fragmentation and negative population growth.

Of these factors, habitat loss due to fragmentation is the principal element of concern to biologists on the Mendocino National Forest. Distribution of suitable habitats, location and direction of river systems, disturb-

ance events, and human management activities contribute to the conditions which old-forest species must adjust to on the Forest (suitable habitat without connecting dispersal habitat).

Fragmentation of habitats can affect wildlife populations in many ways. The probability that a population will persist with habitat loss (one aspect of fragmentation) is largely a function of population density or abundance: the greater the abundance or density the lower the risk of local extinction. Vulnerability to extinction in isolated habitat patches may increase with large body size, low fecundity, specialization on patchy resources, dependence on keystone or link species, occurrence at the edge of the species range, temporal variation in population size, and metabolic rate (Lehmkuhl and Ruggiero 1991).

Fragmentation also leads to a condition where edge habitat is increased. Under these circumstances interior forest habitat becomes limited and edge habitats increase. Competition between interior and edge species may occur when species that colonize early successional habitats and forest edges created by logging use the interior of the remaining forest. An example of this is barred owls, which utilize a more open canopy than northern spotted owls and are a competitor species. Northern spotted owls can be driven out of their established territories by the more aggressive barred owls. Additionally, barred owls can interbreed with northern spotted owls and produce viable young. While they are not known to inhabit the watershed, there are barred owls on the Forest.

Edge creep occurs when processes act upon patch edges to progressively decrease patch area or quality. Some examples are ground fires occurring along patch edges that penetrate the patch and result in the growth of herbaceous vegetation that may provide fuels for subsequent fires that creep further into the patch and renew the cycle; wood cutters who penetrate progressively deeper into a patch to cut snags; and chronic windthrow and subsequent salvage that progressively decrease patch area. Research shows that essential changes in microclimate occur within 525 feet of the forest edge, which creates conditions different from the patch interior. Patches of 24.7 acres or less are essentially all edge and have lost the essential elements of old-growth conditions (Lehmkuhl and Ruggiero 1991).

Studies of predation rates in forest blocks have determined that edge, predator populations, and vegetative structure play significant roles (Andren and Angelstam 1988 and Leimgruber 1994). Great horned owls and goshawks are known to inhabit stands near northern spotted owls. Correlations for this watershed cannot be made without additional information.

Dispersal within the watershed and to adjacent watersheds is important to maintain genetic diversity and population viability. Healthy animal populations are dependent upon movement throughout their home range for a variety of life history functions. The importance of movement between patches of suitable habitat becomes obvious when one thinks in terms of area size and how it relates to reproduction within populations. The size of an area sets the upper limit on the number of individuals occupying it, and the probability for extinction increases with smaller population sizes. This is because smaller populations are more susceptible to demographic instability, inbreeding depression, and inclement environmental conditions (Wilcox 1980).

Demographic uncertainty is defined as the chance events in the reproduction or survival of a finite number of individuals. Healthy populations of sexually reproducing organisms must not only have enough individuals, but also have the right mixture of sexes and the right age structure. A highly skewed sex ratio, periods of poor reproduction, or excessive mortality of a particular age class can threaten the long-term survival of some populations (Thomas et al. 1990).

Genetic uncertainty is also a large factor in maintaining viable populations over time. Loss of genetic variability in populations can lead to reduced fertility, the establishment of deleterious traits within the population, or the inability to adapt to sudden environmental changes. Inbreeding and population bottlenecks, which can lead to a loss of genetic variability, are serious problems for small, isolated populations (Thomas et al. 1990).

Throughout most of the range of the northern spotted owl, dispersal between habitat patches was not considered to be a concern under the Inter-agency Scientific Committee (ISC) rules (Thomas et al. 1990). This is because dispersal habitat was maintained (for the northern spotted owl, but not other old-forest dependent species) through the 50-11-40 rule (precursor to the 11/40 concept already mentioned). The ISC report did have concern for the southern portion of the Mendocino National Forest. The concerns for this area included low population size, lack of local connectivity, and a lack of habitat. Under the ROD the 50-11-40 rule is no longer in effect. Riparian reserves, unmapped LSRs, mapped LSRs, and congressionally withdrawn areas are designed to contribute to dispersal habitat. Individual national forests are left to define dispersal habitat based on local, site-specific knowledge, and to determine if these reserves will provide for adequate dispersal habitat. Care must be taken to maintain dispersal habitat within this watershed and to adjacent watersheds. Using the adaptive management process outlined in the ROD, site-specific analysis may identify the need to implement additional measures to provide for dispersal of old-forest dependent species.

Surveys show a higher number of single spotted owls that are males. It is not known if this is due to surveyor error, an anomaly inherent at the edge of the species range, an indicator of concern, or a normal condition. Further studies should be conducted to determine the causes and consequences of this situation.

Lamberson et al. (1992) document the effects on spotted owls of reduction in dispersal habitat. They modeled a decrease in dispersal success for juveniles seeking new territories and for adults displaced from occupied sites. They also determined that the ecosystem dis-equilibrium resulting from habitat fragmentation continues long after events leading to fragmentation have ended, leading to misinterpretation of both the current state and future trends of the system.

Northern spotted owls are highly territorial and the likelihood of juveniles successfully dispersing to suitable habitat areas will decrease as suitable habitat becomes more patchy in distribution. Failure to disperse successfully will be an additional cause of mortality, especially for juveniles and to some extent all age classes (Lamberson et al. 1992).

The long-term strategy for spotted owl species viability is a network of large LSRs, which will serve as population centers. Currently there is dispersal habitat in matrix lands which contributes to the dispersal of old-forest dependent species. Under the ROD, management activities on matrix lands will result in these lands contributing little, if any, dispersal habitat for old-forest dependent species, and dispersal to areas of suitable nesting habitat may be restricted under these conditions. Spotted owls disperse randomly, making a corridor strategy questionable. Evidence that corridors also facilitate the movement of predators by increasing edge has been documented (Simberloff et al. 1992).

Distribution of owls within the watershed must be assessed and habitat use analyzed to determine impacts of future management activities. Occupancy data should be utilized with caution when determining long-term abundance because crowding (packing) of adults can occur when habitat is limited. Approximately five spotted owl activity centers appear to be concentrated in a 4-mile by 1-mile area. This may be caused by a lack of suitable nesting habitat, or the lack of dispersal habitat. If owls are not able to disperse between mapped LSRs, then population viability may be questionable. Projects that enhance dispersal habitat and link LSRs would help ensure a viable population of spotted owls.

Currently there are approximately 8,843 acres of dispersal habitat within the riparian reserves of this watershed. The acres of potential dispersal habitat can be calculated by adding up the plantation acres, acres of vegetation expected to provide dispersal habitat when it matures, and the current acres of dispersal habitat within riparian reserves. There are approximately 22,569 acres of potential dispersal habitat within the riparian reserves in this watershed. Chapter 11, restoration, contains many restoration opportunities that will be beneficial to the restoration of dispersal habitat in riparian reserves. This may be true even when it was not identified, and there may be additional opportunities beyond those listed.

Species such as the Pacific fisher and marten are more directly impacted by these conditions. Mammal species are more restricted in movement through unsuitable habitats due to the fact that they cannot fly over barriers. Protection of habitat blocks for avian species may not consider the needs of mammals. More information is needed regarding these species (see Section 13.2).

Bald Eagles

The Aquatic Conservation Strategy should benefit bald eagles by protecting nesting and roosting sites, and by improving habitat conditions for fish, thereby providing an increased prey base.

The Proposed Forest LRMP indicates that the Forest should be supporting three pairs of bald eagles. With the latest information on the number of eagles at Lake Pillsbury, we may be meeting the expected number. It is not known how many nesting eagle pairs the Lake can support, and how much impact continued or increased recreation will have on the ability of the bald eagles to reproduce at Lake Pillsbury.

The Recovery Plan for the Pacific Bald Eagle (USDI Fish and Wildlife Service 1986) and recent literature (Anthony et al. 1994) show a correlation between human disturbance and nest failure. Additionally, pesticide contamination remains the primary cause of nest failure for bald eagles (Anthony et al. 1994). During peak recreational-use weekends, eagle foraging may be impacted by the intensity of recreational use at Lake Pillsbury. Recreational use appears to be negatively influencing these birds during these times. Paving of the road or airstrip, or an increase in facilities or recreational activities, may affect the bald eagles and cause them to abandon this area as a breeding site.

Peregrine Falcons

Because there has been a lack of monitoring of the potential and enhanced nest sites for peregrine falcons it is difficult to predict future trends. Watershed health is expected to increase due to implementation of the Aquatic Conservation Strategy; therefore, the avian prey base for peregrine falcons should increase, having a positive impact on the falcons.

As the Forest is expected to follow the direction in the Peregrine Falcon Recovery Plan (USDI Fish and Wildlife Service 1982) and is planning to write management plans for active eyries when located, this should assure that the life history needs of the peregrine falcons in this watershed will be maintained or enhanced. Additionally, as potential nest sites are annually surveyed, this would assure identification of nesting activities before management activities had the potential to disrupt reproduction.

TE&S Plants

As more information is gathered from site-specific analysis, there should be increased information regarding additional areas that contain threatened, endangered, and sensitive plants. This information can then be used to protect or manage these sites in accordance with the Proposed Forest LRMP. The use of prescribed fire in the future has the potential to affect threatened, endangered and sensitive plants. If these plants are present in proposed project areas, decisions regarding whether or not to burn and the season of the burn will be analyzed as a part of the project NEPA analysis.

Management Indicator Species and Neotropical Migrant Birds

Without past or current population information about these species, future population trends about these species cannot be predicted. As the use of prescribed and natural fire in this watershed is expected to increase, habitat for early successional species should be maintained.

6.0 ISSUE 4--PLANT COMMUNITY CHANGES

6.1 Issue Statement

Concern exists that management activities and natural processes have encouraged development of plant communities in the Upper Main Eel watershed that may be more susceptible to large-scale disturbance events and may have reduced overall ecosystem health. Wildland plant communities are dynamic, interactive groups of organisms. In addition to changes in response to natural processes, plant communities in this watershed have changed in response to attempted exclusion of fire, reforestation, harvesting, and attempted preservation. In parts of the watershed, successful fire suppression has caused changes in plant species composition, vegetation community structure, volume and distribution of downed woody material, and distribution of vegetation types at a landscape scale. In other parts of the watershed, high-intensity fires and associated reforestation and salvage logging have reset the successional clock simultaneously on large areas.

The result is a landscape that is susceptible to severe large-scale fire disturbance and insect infestation events and has a reduced and endangered complement of key disturbance-dependent seral vegetation types.

6.2 Desired Conditions

There is a mosaic of vegetation that is not susceptible to large-scale, intense fire disturbance events, maintained through the use of natural processes and by management actions which mimic natural processes.

There is a mosaic of vegetation that contains densities, age distribution, species composition, structural characteristics, and spatial distribution such that plant diversity is stable over time across the watershed.

There is a mosaic of vegetation characteristics including downed woody material and snags that allows a full range of fire management strategies while meeting multiple resource needs including safety of forest workers and users.

The condition of the vegetation is such that healthy ecosystems are maintained and distribution of seral stages meets management needs while contributing to ecosystem integrity.

6.3 Key Questions

What are the current plant community characteristics, distribution, stocking levels, and species composition? (See Section 6.5.)

What are the past and current fire regimes? (See Sections 6.4, 6.5, and 6.6.)

How has fire exclusion changed vegetation characteristics over time, and what effects have those changes had on the diversity, abundance, and distribution of wildlife populations that use this watershed? (See Sections 6.4 and 6.5.)

What are the existing fuel characteristics and how have they changed over time? (See Sections 6.4, 6.5, and Chapter 13.)

What is the scope and trend in occurrence of stand replacing fires? (See Sections 6.4, 6.6, and Chapter 13)

What is the historic fire occurrence and what are the causes of these fires? (See Sections 6.4 and 6.5.)

What is the potential risk of wildfires? (See Section 6.6.)

What is the historic pattern of vegetation on the landscape? (See Section 6.5, 6.5, and 6.6.)

What projects would help achieve the desired conditions? (See Sections 6.6 10.3, 11.2, and 12.2.)

What types (and locations) of activities should be undertaken to reduce fuel loading and encourage establishment of desired distribution of seral stages and vegetative characteristics? (See Sections 10.3 and 11.2.)

6.4 Past Conditions and Processes

Plant Communities

We can only estimate and describe past conditions in terms of what currently exists and what the likely differences were from current conditions. The forest plant communities that now occupy the Upper Main Eel watershed are not like those that occupied the area 200 years ago. Density of shade-tolerant species in the understory and density of all species was probably lower in the forests that existed before Euro-American occupation and management. The evidence of change is particularly evident in hardwood stands and grasslands. It is difficult to find an older black oak stand that does not have a large invasion of Douglas-fir and white fir in the understory. Mixed hardwood-conifer stands that have conifers over-topping and eliminating the large, old hardwoods from the forest can also be observed in the forests of this watershed.

The likelihood of a change to more shade-tolerant conifers is supported by pollen studies such as the one conducted at A-M Lake (within the Middle Fork Eel River watershed) (West 1991). These studies show an acceleration of the increase of Douglas-fir pollen in the lake within the last 100 years. Since the amount of Douglas-fir would increase in response to a reduction of disturbance, these data support qualitative data suggesting a change in species mix. While the acceleration of the pollen changes noted in the recent past at A-M Lake is not corroborated in a similar study at Tule Lake (in the Upper Main Eel watershed), the proportion of true fir (*Abies*) pollen is near historic high levels. White fir and Douglas-fir would respond similarly to fire exclusion. The lack of evidence of an acceleration from the Tule Lake study in the last 100 years may be because the study is not sensitive enough to discover trends in that short a time frame.

Disturbance Patterns

Major disturbance agents that have affected the vegetation of the Upper Main Eel watershed are landslides, insect infestations, wind, floods, and fires. Logging and road construction have affected localized areas. Riparian vegetation has been greatly altered by landslides, road construction, and floods, while upland vegetation has changed in response to fires, fire suppression, and harvesting of wood products. Disturbance events in riparian plant communities were discussed in more detail in Chapters 3 and 4.

While harvesting, blow down, insect and disease epidemics, and flood events have created changes in the vegetation of the Upper Main Eel watershed, the most significant agent of change in terrestrial ecosystems is the occurrence of fires. This watershed analysis presents an opportunity to describe the fuel and fire regime conditions and examine conditions in the context of the area's natural range of variability. It will also explore fire and fuels management opportunities based on condition trends and the potential future effects of past activities.

In order to fully describe the fire regime and fuel conditions for the Upper Main Eel watershed, intensive fuel inventory and fire history studies could be initiated. Plot and transect data could be collected throughout the watershed to typify fuel loadings, fuel depths, decomposition rates, and stand structure (i.e., ladder fuels). Fire history studies would document pre-settlement and suppression-era fire frequencies, intensities, sizes, causes, season, and juxtaposition. Weather patterns could also be investigated to analyze the connection between fire sizes or intensities and precipitation records. Financial and time constraints will not allow for this amount of detail. Direction for preparation of watershed analyses precludes undertaking large field inventory and examination programs, but instead directs forest analysis team members to use existing data. Data from other areas and sources can be used to reach reasonable conclusions regarding fire regimes and fuel conditions within the Upper Main Eel watershed.

Fire Occurrence And Frequency

Minimal studies of prehistoric fire occurrence have been conducted within the Upper Main Eel watershed, but studies have been conducted on the adjacent Six Rivers National Forest and other areas within the Klamath Physiographic Province ecosystems. Prehistoric fire dating with slabs was done on the Six Rivers National Forest in Douglas-fir clearcut areas where trees dated back to 1750 (Salazar 1994). Preliminary results from this unpublished study on the Mad River District showed mean intervals of 12.7 years between fires intense enough to leave scars. From the all-aged nature of the old-growth Douglas-fir stands that they surveyed, and the infrequent scarring of trees, the surveyors in this study concluded that frequent, low-intensity ground fires were the common type of fire rather than stand-replacing, high-intensity fires.

In the Siskiyou Mountains portion of the Klamath Physiographic Province, Agee (1991) analyzed fire slabs for the period 1650 to 1930. He found natural fire rotations varying from 37 years in the Douglas-fir/oak type to 64 years in the white fir/herb type.

On the Salmon River Ranger District of the Klamath National Forest, Wills and Stuart (in press) analyzed fire slabs within the Douglas-fir/hardwood forest. Their study involved three sites and split the analyzed time intervals into pre-settlement (1745-1849), settlement (1849-1894), and suppression (1894-1987) periods. The range for the mean fire return interval for the three periods was:

Pre-settlement	10.3 - 17.3 years
Settlement	9.2 - 16.0
Suppression	28.7 - 46.5

Douglas-fir/mixed evergreen forests were investigated on the South Fork of the Eel River, on the eastern edge of the north coast redwood forest (Salazar 1994). The average fire frequency for the area was found to be 12.3 years. These researchers also used three time periods which resulted in the following fire frequencies:

Pre-settlement (1827-1885)	11.3 years
Settlement (1885-1925)	8.0
Suppression (1925-1950)	13.5

They concluded that settlers and Indians burned repeatedly. The frequent burning was thought to explain the patchiness of the landscape, and would explain the old, pure stands, and the open nature (with little understory) of many mixed stands, in addition to the presence of distinct age classes.

In a small study within the Middle Fork Eel watershed, stump scars indicated that, on average, a fire intense enough to scar trees occurred every 30 years. Additional small studies conducted in the Sugarfoot Fire area of the Corning Ranger District (Hopkins 1994) and on the Upper Lake District (Rubiaco 1994) showed a fire return interval between 10 and 21 years for low elevation ponderosa pine dominated forest. The study by Rubiaco included trees from the Upper Main Eel watershed. Slab analysis is limited to detecting fires that were

intense enough to leave scars on trees. It is probable that many low intensity fires occurred that did not leave scars. Based on these studies it is reasonable to state that the average interval between scarring fires prior to effective fire suppression would be between 10 and 25 years for most of the lower elevation forest ecosystems of the Upper Main Eel watershed.

American Indian Use Of Fire

A significant cause of fire ignition during the prehistoric era was American Indian use of fire. Fire was the most significant management tool used by California American Indians (Anderson 1993). There is evidence for almost every tribe in the western United States having used fire to modify their environment (Lewis 1993), and the native populations (Onkolukomnom, Huchnom, Yuki, and Eastern Pomo) that inhabited the Upper Main Eel watershed appear to be no exception. Human-caused fires were probably a more significant factor than natural fires in influencing vegetation and the environment. If only naturally ignited fires had occurred, a greater number of conifer stands would have been present in 1865 than the data show (Keter 1987).

Unfortunately, the history of fire use in the Upper Main Eel watershed remains sketchy. No specific information has been found regarding how the native populations practiced burning; however, there are a number of references to burning in the ethnographic data for the Pitch Wylacki (Keter 1987), and it is probable that the burning practices of the neighboring tribal groups living in the Upper Main Eel were similar. Intensive burning practices probably occurred with some regularity only in proximity to major settlements, rather than in distant upland areas (Greenway pers. comm.).

Several purposes for burning by the American Indians of the Upper Main Eel watershed have been noted. These include fire management, maintenance of habitat diversity, favoring vegetation for food sources, and producing quality vegetative material for baskets and other implements.

Fire Management

There are several references in the literature to the use of burning for the purpose of fire management. Light surface fires in the grasses around oaks were used to protect them; the fires were designed to reduce encroachment by shrubs and conifers which eventually might act as fuel ladders to oaks, igniting the canopies (Anderson 1993). Burning of needles and debris in general precluded excessive accumulations of fuel so that destructive wildfire conditions did not develop (Lewis 1993). Burning was rarely done during mid-summer and early fall when the forests were most vulnerable to catastrophic wildfire (Williams 1994).

Maintenance of Habitat Diversity

Generally, the American Indians burned parts of the ecosystems in which they lived to promote a diversity of habitats, especially increasing the "edge effect," which gave greater security and stability to the Indians' lives. This use of fire was different from that of white settlers, who burned to create greater uniformity in ecosystems (Williams 1994).

Along the North Fork of the Eel River region (and likely in the Upper Main Eel region as well) it appears that burning was a primary factor in determining forest composition prior to 1851, and subsequent lack of intensive burning has allowed development of Douglas-fir stands within many of the oak woodland areas (Keter 1986, 1987). Keter notes that for much of the North Fork basin, the oak-woodlands are the seral (intermediate succession) stage for the mixed evergreen forest, which in this area is dominated by Douglas-fir. He hypothesizes that the Indian people were managing the land with fire, ultimately preventing the climax stage of Douglas-fir from occurring throughout much of the area. Grass fires reduced the mass of needles and

debris, leading to more abundant shrubs and herbaceous plant browse, which led to greater numbers of animals on summer feeding ranges and under conditions in which they were more easily hunted (Lewis 1993).

The oak woodlands also provide acorn crops and other plant resources which are not available in Douglas-fir forests. By preventing the establishment of the climax vegetation community, the oak-woodland environment was "managed" to maintain species habitat and diversity. By consciously manipulating their environment, local groups maximized the availability of the food resources they exploited.

Vegetation Management to Favor Food Sources

Application and careful control of burning were particularly important to the manipulation of the oak-acorn resources. The ages and size of oaks suggests that burning was pursued aggressively by tribes. Burning destroys conifer seedlings, but oaks can re-sprout, so they can maintain site occupancy instead of giving way to species that grow taller. In addition, regular grass fires led to increased production of acorns and oak leaves, due to the decreased competition from thinned understory of brush (Lewis 1993). Black oak stands were burned in the fall by American Indians at least every one to several years, and each fire broke the life cycle of the filbert weevil and the filbert worm, ensuring a worm-free acorn crop. The worm drops out of trees, has its reproductive cycle in the ground beneath the trees, and emerges to re-infect the acorns. Burning removed old worm-infested acorns on the ground (McCarthy 1993). Burning also served to clear the ground to facilitate the gathering of acorns and to improve growth and yields of seed and berry plants for food sources (Williams 1994).

Favoring Basketry Material

Burning was used to improve the quality of basketry materials by encouraging the growth of young pliable shoots (Keter 1987). For example, suppressed buds along the base, or root crown, of redbud and oak trunks or on the root crown are released by fire, sending up long, straight, flexible switches useful for making basketry material. Since significant quantities of oak shoots were needed for certain types of baskets, deliberate burning under the oaks stimulated this vegetative reproduction (Anderson 1993).

Historic Fire Occurrence

For fires that occurred during the historic period, Forest Service fire report records provide data that can be used to study fire periodicity. These data go back to 1911 and include the period up to 1990. The Forest Service records document 797 fires within the Upper Main Eel watershed (493 human caused and 304 caused by lightning). Additional fires adjacent to this watershed probably would have affected the watershed if suppression action had not been effective.

The distribution of fires by size class was:

Size Class	Acres	Number	Percent
A&B	0-9.9	649	81
C+	10 +	148	19

Of the 148 fires greater than 10 acres within the Upper Main Eel watershed boundary, 128 were caused by human activities and 20 were caused by lightning. Despite the best human efforts over the last 90 years to suppress wildfires in the watershed, over half of the watershed has been impacted by fire. Figure 6-1 shows that about 15 percent of the watershed was burned more than once during the period 1911-1989.

Wildfire suppression activities have changed the structure and distribution of vegetation and downed woody material. A body of information exists from surrounding areas that contributes to our understanding of these changes within the Upper Main Eel watershed. Although as we observe these changes now, they appear to have been quietly occurring for decades, some close observers started to see changes in the forest almost immediately.

In 1922 the grazing chapter of the Supervisor's Annual Working Plan for the California National Forest (later renamed the Mendocino National Forest) stated in part, "Since the creation of the Forest there have been few serious fires on sheep ranges and the oak brush has, over large areas, grown so high and thick that it does not furnish the sheep feed it formerly did. During these years of fire protection, it is undoubtedly true that coniferous reproduction has come in very extensively and in places is further decreasing the forage capacity. While damage to the reproduction is noticeable here and there, there is undoubtedly a large amount of reproduction coming in on the sheep ranges. While the condition of the ground feed may have deteriorated, there is no doubt but that the timber stand has increased in area and density, so that from a timber standpoint we are gaining (barring insect depredation)"

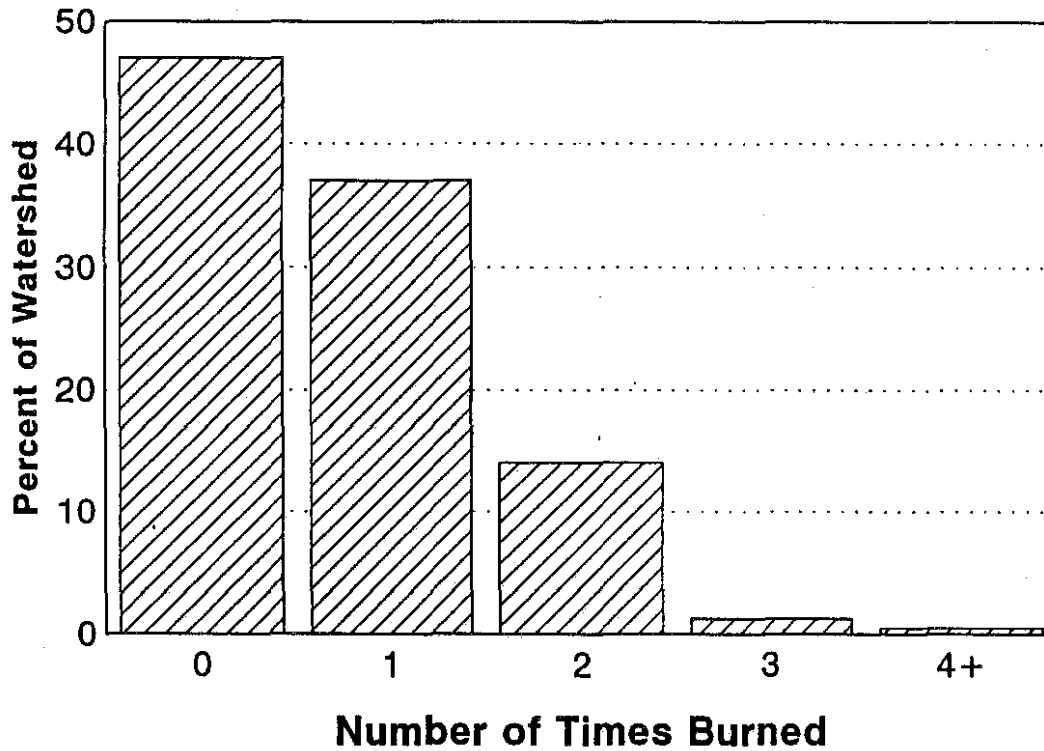

Figure 6-1. Frequency of fires in the Upper Main Eel watershed, 1911-1989.

Suppression became progressively more effective in the 1930s with the Civilian Conservation Corps (CCC) and after World War II, with an increase in mechanized (bulldozer) and aerial strategies. This has resulted in significant increases in accumulated fuels (both living and dead) within forests of the Klamath Physiographic Province. Success in fire suppression has induced changes in forest cover and density which in turn have resulted in changes in fire frequencies and intensities. The conditions noted in this watershed have been occurring throughout the wildlands of the western United States, and have resulted in a change in the amount of area burned annually (see Figure 6-2). Among the potential reasons for this trend is the increase in fire suppression technology and resources between 1916 and 1965 and the worsening of the fuel mosaic from 1950 to present (Agee 1993).

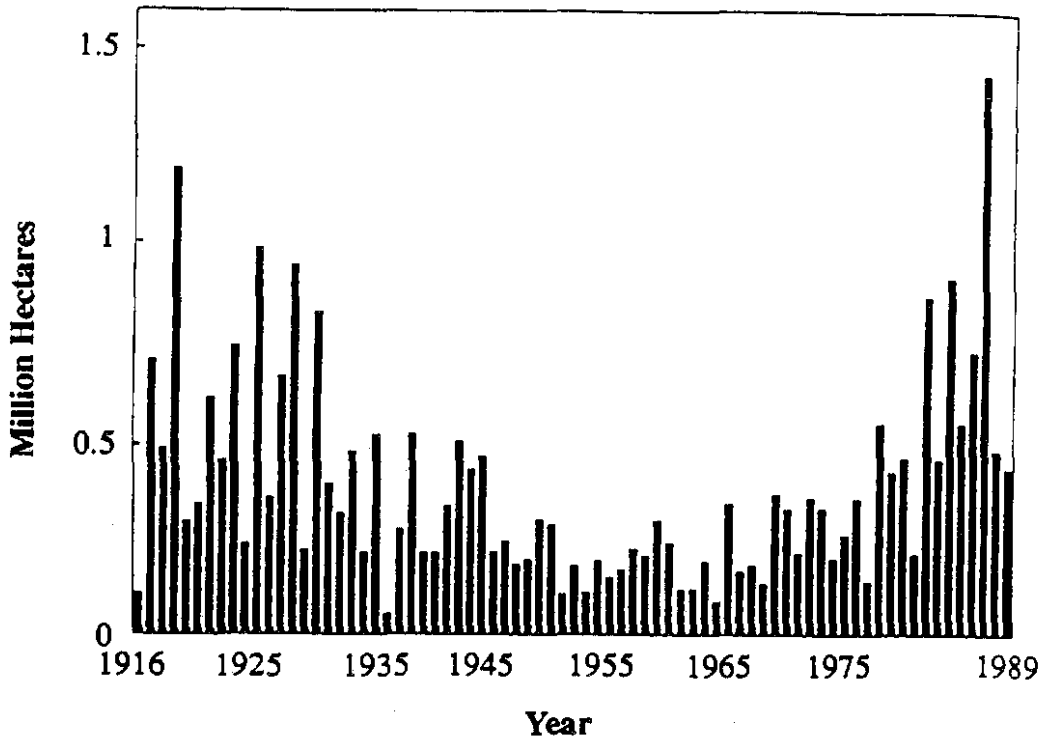

Figure 6-2. Area burned annually in 11 western states, 1916-1989.

These changes in fire events, whether in terms of fire frequencies or intensities, can have a substantial effect on biodiversity, wildlife habitat conditions, and forest health. One objective of ecosystem analysis and management is to identify disturbance agents and regimes and to manage the landscape in a way that mimics or reestablishes processes and timing of disturbances. This means that fire is a recurring event that is neither "good" nor "bad" and should be used or suppressed to achieve ecosystem management objectives at the landscape level.

Fire suppression activities have changed the fire regime for the low-elevation ponderosa pine and mixed conifer forests throughout the west (Agee 1993), and in this watershed, from one characterized by frequent, light surface fires to one of crown fires or infrequent, severe surface fires. This change in fire return interval has also affected disturbance-dependant ecosystems such as knobcone pine forests, hardwood forests, chaparral and glade ecosystems. Comparing prehistoric fire occurrence information with the information available during the historic, or fire suppression, period shows that fewer acres of the watershed were burned annually during the fire suppression period. We can conclude that in this context, fire suppression has been successful. This success has resulted in changes in fuel loading and vegetation conditions. The resultant fire intensity, when these areas burn, causes effects so severe that the affected areas are not able to meet resource objectives. Average fire return intervals have changed from the 10-20 year interval for the period before fire suppression to over 48 years now.

Air Quality

Basing an assessment of particulate emissions on the number of acres burned, it is apparent that annual emissions were higher before fire suppression than they are today. Many fall and summer days must have had smoke emissions occurring. Total emissions during the fire suppression era were probably similar to

today with fewer days of emissions and higher emissions per day. Total emissions over longer time horizons are probably equal.

6.5 Current Conditions and Processes

Plant Communities

Vegetation in the Upper Main Eel watershed is a mosaic of vegetation types. This mosaic consists of blocks and stringers of conifer and conifer-hardwood vegetation broken by shrub, grass, and barren areas. This vegetative mosaic is a result of multiple factors. Human-caused and natural disturbance events of varying intensity and scale have resulted in a very diverse mixture of vegetation. Soil and climatic factors and plant adaptation have added to the variety of the plant life present. While in general the watershed is extremely diverse, a large majority of the landscape is occupied by a mixture of coniferous species in combination with other plants. Figure 6-3 shows the current area occupancy by vegetation types.

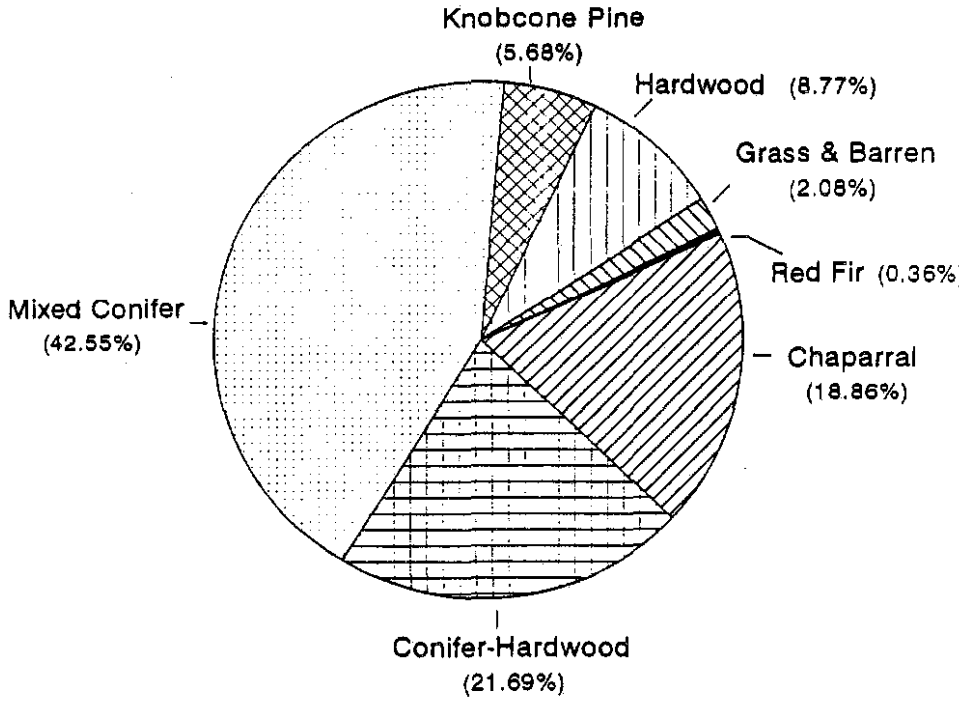

Figure 6-3. Distribution of vegetation in the Upper Main Eel watershed.

Review of vegetation type and seral stage distribution in Figures 6-4 through 6-7 reveals a roughly even distribution of size classes in the hardwood and hardwood-conifer vegetation types. Project planning should explore whether distribution over the landscape is adequate for specific, local areas. In the mixed conifer vegetation type (see Figure 6-4) it appears that multi-layered (or developed) stands may occur at a lower than proportional level and that younger, single-layer stands may be relatively abundant. How conifer vegetation types pass through seral stages over time will have an important influence on quality of habitat available as well as potential for production of goods and services. Not represented in the graphs are the conditions in the brush, knobcone, and grass vegetation types. These types need periodic disturbance in order to persist. Currently the grass-dominated areas within the watershed are being invaded by a combination of trees and shrubs. A large proportion of the brush vegetation types are dominated by older vegetation that has not been

disturbed for long periods of time. Knobcone pine stands that have been undisturbed are being invaded by disturbance-intolerant conifers.

A more detailed breakdown of terrestrial vegetation in the Upper Main Eel watershed is given in Table 6-1 Size class distribution of the four major forest vegetation types found in this watershed is shown in Figures 6-4 through 6-7. These graphs show the relative number of acres present in the various vegetation types by size class. These tree sizes can be roughly equated to seral stages, with larger tree sizes representing later seral stages.

Table 6-1. VEGETATION TYPE AND SIZE CLASS ACREAGE BY LAND ALLOCATION

Vegetation Type and Size	Wilderness	LSR	All Other	Subtotal	Total
Mixed Conifer					77,987
•Plantations	29	10,635	9,575	20,239	
•Saplings	469	1,760	1,925	4,154	
•Poles	535	3,235	2,696	6,466	
•Young Mature	1,340	5,519	9,181	16,040	
•Older Mature	1,623	11,561	7,924	21,108	
•Multi-layered	761	6,956	2,263	9,980	
Conifer-Hardwood					39,753
•Sapling/Pole	507	11,517	10,887	22,404	
•Mature	851	8,536	7,962	17,349	
Red Fir					664
•Sapling/Pole	0	133	150	283	
•Mature	0	179	202	381	
Hardwoods					16,080
•Sapling/Pole	641	1,224	4,640	6,505	
•Mature	2,129	2,649	4,797	9,575	
Knobcone Pine					10,408
•Sparse	450	1,521	4,372	6,343	
•Dense	668	1,977	1,419	4,064	
Chaparral	1,230	5,910	27,433	34,573	34,573
Grass	14	520	2,012	2,546	2,546
Barren	232	379	660	1,271	1,271

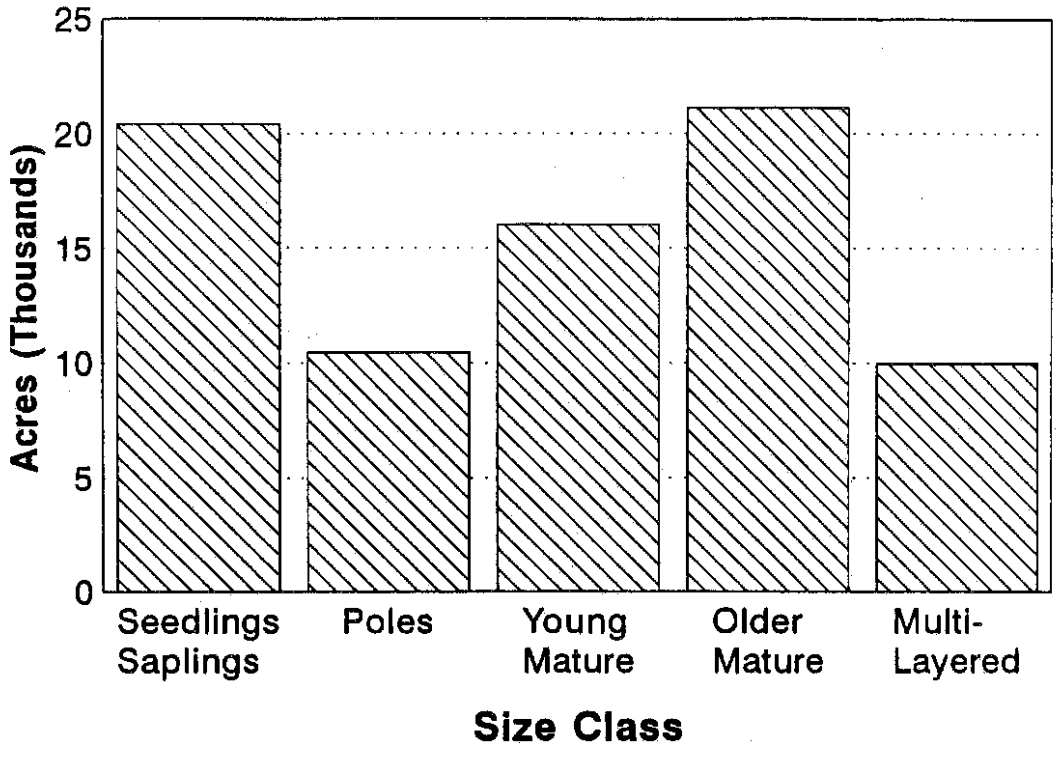

Figure 6-4. Acres of mixed conifer by size class in the Upper Main Eel watershed.

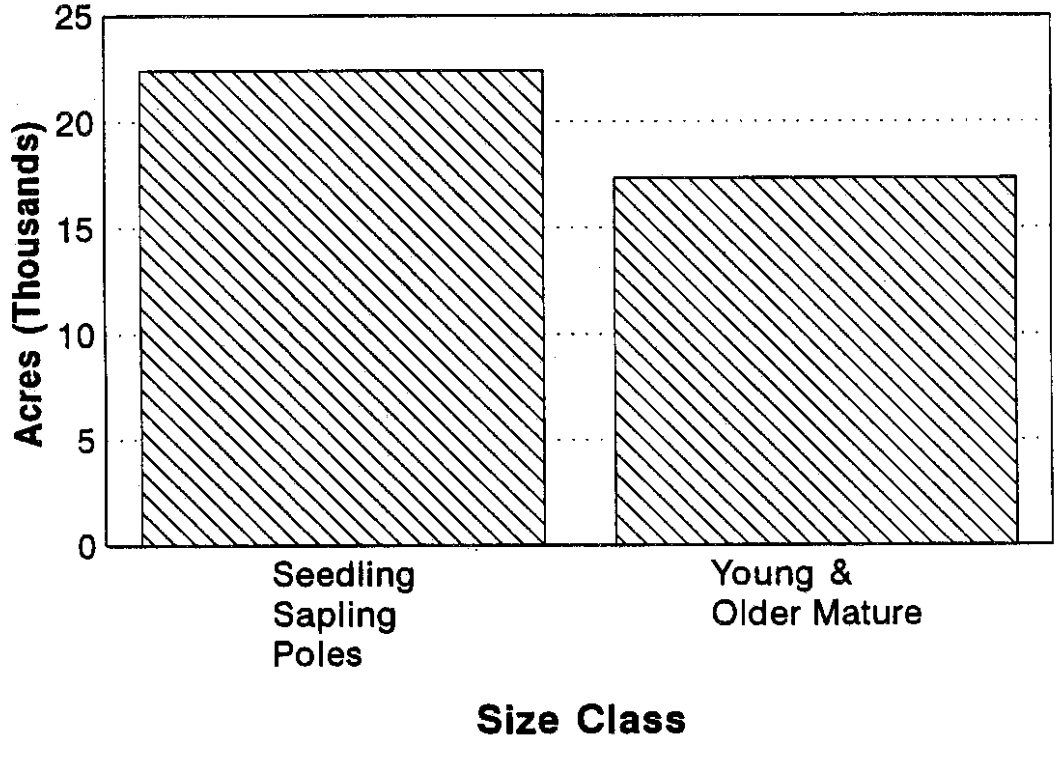

Figure 6-5. Acres of conifer hardwood by size class in the Upper Main Eel watershed.

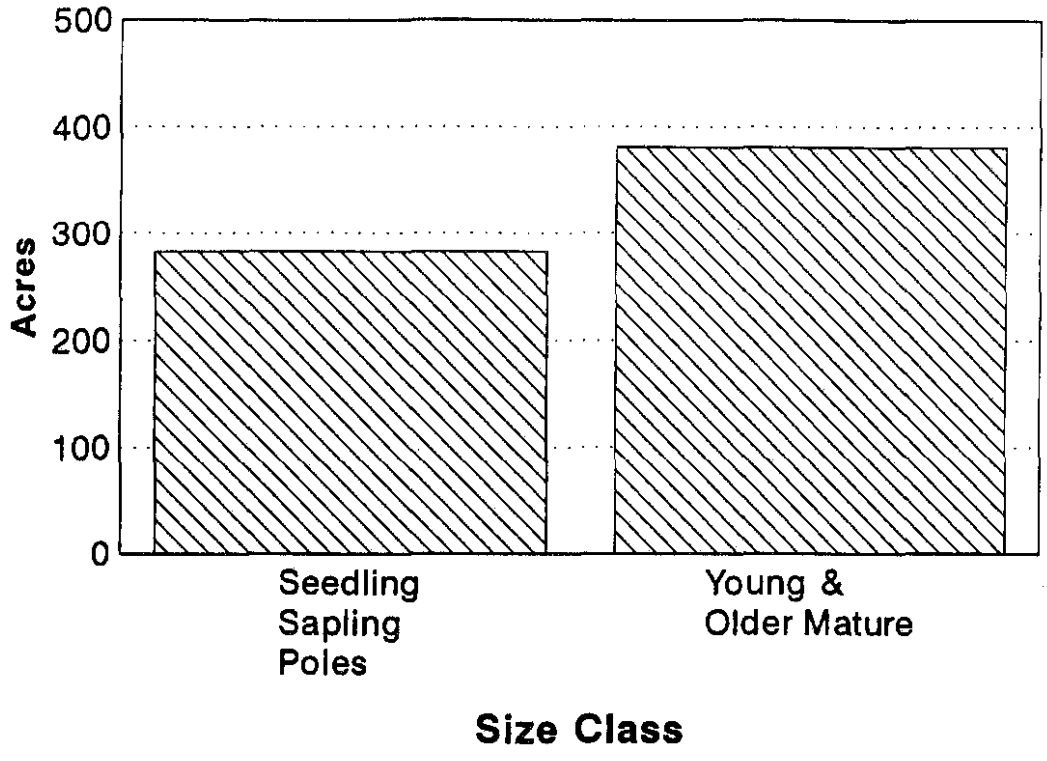

Figure 6-6. Acres of red fir by size class in the Upper Main Eel watershed.

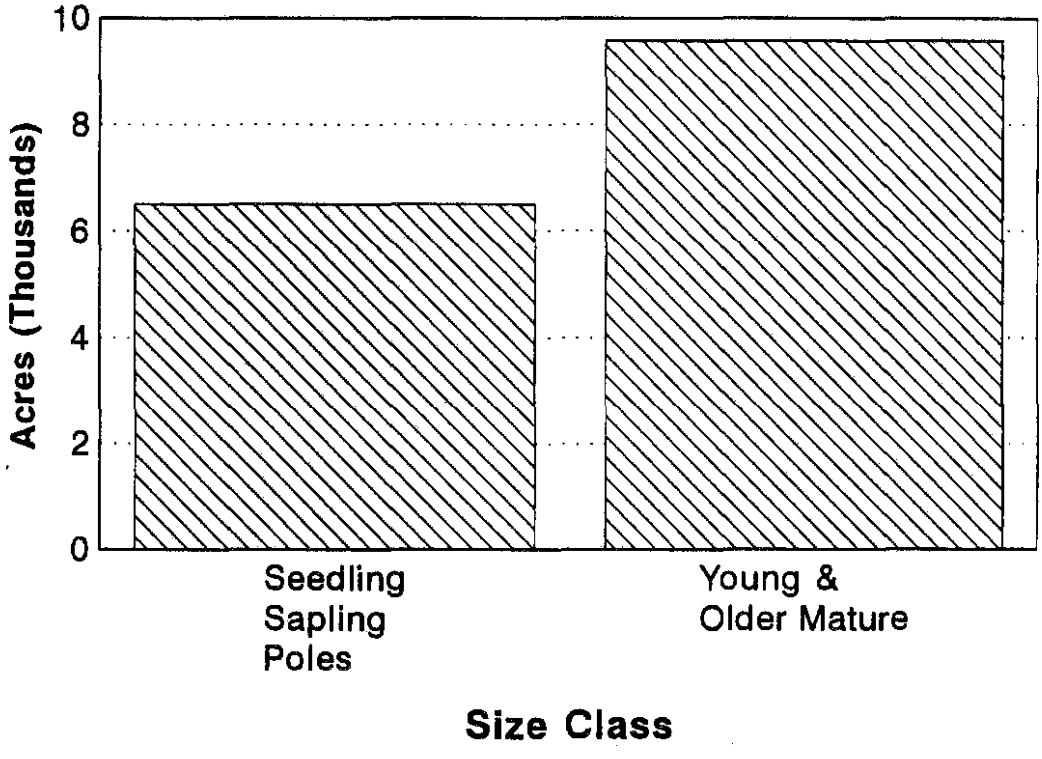

Figure 6-7. Acres of hardwoods by size class in the Upper Main Eel watershed.

Vegetation types were mapped for the Upper Main Eel watershed using existing data from vegetation typing developed for the Land Management Plan for the Mendocino National Forest. Vegetation typing was based on aerial photographic interpretation and aggregated into larger, homogeneous groupings called strata. The data presented in Table 6-1 and associated graphs use this strata data. The groupings conform to the Pacific Southwest Region timber inventory strata definitions as applied in the Mendocino Land Management Plan. The typing was done from 1978 photography and updated to 1991 to reflect changes in the vegetative mosaic. The distribution of forest vegetation in the watershed is shown in Plate 5 and of non-forest vegetation in Plate 6, at the end of this analysis.

Over 20,000 acres of conifer plantations exist within this watershed. These plantations have been established over the last 30 years in response to various management objectives and include reforestation after wildfires, after harvesting, and in efforts to convert chaparral vegetation to forests. Pioneering efforts were used to establish the technology of conifer reforestation and primarily focused on the conditions that achieved successful survival of the planted trees. These early plantations generally were intensely site prepared and planted with ponderosa pine, since it is most successful in plantings. Later plantations utilized less disruptive site preparation methods and the goal was to establish a tree species mix that reflected what had occurred naturally on each site. The plant communities created in these plantations appear simpler in species composition and more uniform in density than naturally established stands. However, a comparison of these plantations to stands of similar ages that have not been naturally established after coarse-grained disturbance events such as stand replacement fires indicates that they are not as different as they first appear. The primary differences are that plantations have fewer trees per acre and as a consequence are growing and developing faster.

Riparian plant communities vary site by site throughout the watershed. Some riparian areas within this watershed generally have a high density of water- dependant vegetative species such as willows (*Salix* spp.), cottonwood (*Populus* spp.) and alder (*Alnus* spp.). The understory is occupied by various ferns, bunch grasses, and sedges. Large Douglas-fir and incense cedar in the riparian vegetative communities are sources of large woody material for channel structure. Some riparian zones are dominated by large conifers. Many of the recently disturbed riparian areas within the Upper Main Eel watershed are deficient in crown cover of intermediate layers of vegetation and deficient in large trees both as a source of woody material and for channel shade.

Form and function of vegetation affects many dependant organisms and ecosystem components. Roots increase shear strength by increasing apparent cohesion of the soil. Roots can increase shear strength as much as two- and three-fold (Gray 1974). The depth of rooting is very important. Different species of trees, brush, and grasses have differing rooting characteristics. Some trees send roots to great depths within the soil profile including the base of the soil at the bedrock contact, while other trees tend to have their roots concentrated in the upper few feet of soil. Brush will also have a variety of rooting characteristics depending on species. Trees and shrubs with strong, deep penetrating roots are the best in adding cohesive strength and attaching the soil mantle to bedrock. This slows or stops the smaller translational slides and earth flows.

Plants remove water from the soil mantle through evapotranspiration. Removal of water reduces pore pressure, seepage, and uplift forces. The rate of water removal is dependent on the density and foliage characteristics of the plants. Evergreen plants actively take up water throughout winter and early spring while deciduous plants delay uptake of water until spring. Depending on species, some conifers remove more water from the soil than deciduous trees. Conifers also directly intercept more precipitation than a deciduous tree. The water needed to maintain cool water for summer fish habitat is potentially lost through spring and summer evapotranspiration. At higher elevations conifers capture snow and rain on their foliage where it evaporates, resulting in less moisture reaching the ground.

Grasses, when fully developed, have a very thick root mass extending down several feet which provides excellent soil-binding properties. Grasses are good at preventing direct raindrop impact and surface erosion. Annual grasses will have shallow roots just after they germinate in the early part of the growing season and,

as a result, will provide little protection if the first rains of the season are very heavy. The perennial and bunch grasses which go dormant during the dry season have roots already established in the soil. Thus, they provide more protection from early season rains than annuals, and growth starts sooner after the first fall rain. Perennial and bunch grasses are harder to establish but once established they provide better soil protection.

Disturbance Patterns

Disturbance events are generally stochastic, with wildfires, slides, wind and insect events occurring at intermittent and unpredictable points in time. Current disturbance patterns reflect the historic frequency and scale discussed in Section 6.4. A comparison of acreage burned in this watershed with the rate of acreage burned on the Forest as a whole shows that fire impacts the Mendocino National Forest at a rate of 0.23 percent per year. The Upper Main Eel watershed accrues impacts from fire events at a rate of 0.85 percent per year, a rate over 3.5 times the Forest average. Table 6-2 shows the acreage of the watershed that has been burned and the number of times burned during the period 1911 through 1994, ostensibly a period of fire exclusion.

Table 6-2. FIRE OCCURRENCE, 1911-1994, IN THE UPPER MAIN EEL WATERSHED, MENDOCINO NATIONAL FOREST

	1911-1950	Yearly Ave.	1951-1994	Yearly Ave.	Total	Yearly Ave.
Total Fires						
•Mendocino NF	1518	38.0	2249	51.1	3767	44.8
•Upper Main Eel	316	7.9	481	10.9	797	9.5
•UME/MNF	21%		21%		21%	
Human-Caused Fires						
•Mendocino NF	1032	25.8	902	20.5	1934	23.0
•Upper Main Eel	218	5.5	275	6.3	493	5.9
•UME/MNF	21%		30%		25%	
Lightning-Caused Fires						
•Mendocino NF	486	12.2	1347	30.6	1833	21.8
•Upper Main Eel	98	2.5	206	4.7	304	3.6
•UME/MNF	20%		15%		17%	
Total Acres						
•Mendocino NF	Unk.	N/A	173,894	3952	Unk.	N/A
•Upper Main Eel	Unk.	N/A	50,086	1138	Unk.	N/A
•UME/MNF			29%			
Fires ≥10 Ac						
•Mendocino NF	491	12.3	138	3.1	629	7.5
•Upper Main Eel	119	3.0	29	0.7	148	1.8
•UME/MNF	24%		21%		24%	

Table 6-2. FIRE OCCURRENCE, 1911-1994, IN THE UPPER MAIN EEL WATERSHED, MENDOCINO NATIONAL FOREST (continued)

	1911-1950	Yearly Ave.	1951-1994	Yearly Ave.	Total	Yearly Ave.
Human-Caused Fires ≥10 Ac						
•Mendocino NF	423	1.6	103	2.3	526	6.3
•Upper Main Eel	104	2.6	24	0.5	128	1.5
•UME/MNF	25%		23%		24%	
Lightning-Caused Fires ≥10 Ac						
•Mendocino NF	68	1.7	35	0.8	103	1.2
•Upper Main Eel	15	0.4	5	0.1	20	0.2
•UME/MNF	22%		14%		19%	

Several methods of measuring fuel inventories exist. The most intensive method is Brown's (1974) transect method, which measures the numbers of intersections of different-sized fuel particles along varying lengths (depending on the debris diameter) of a transect. Conversion factors are used to determine fuel loading by size classes from these data. A less intense method is the use of photo series, which correlates photos of typical conditions of vegetation types and size classes to fuel loading by size class, residue depths, and assessments of fire behavior and suppression difficulty. Some areas of the Upper Main Eel watershed have been inventoried using these methods for past project activities. Current fuel loading is not available on a landscape scale.

Fire behavior information can be obtained on a landscape scale through the use of fuel models. This more generalized, descriptive method uses classes or groupings of fuel properties that are necessary for fire behavior and fire danger modeling. Fuel models are grouped into four categories--grasses, shrubs, timber, and slash. Their description includes ranges of data on fuel loading by size class, fuel depths, and moistures of extinction. Data from both photo series and Brown's transect inventories were used to select fuel models most appropriate for use in describing the Upper Main Eel watershed. To improve predictability, the following vegetation-fuel model links were made: Grass areas are best represented by fire behavior Model 3, Brush areas are either represented by model 4 (for chamise), and forested areas are best modeled using models 9 (for forests that have little understory vegetation), or 10 (where understory forest layers have developed).

Using these fuel models and estimating the weather factors present for a late summer day, the following flame length ranges can be expected:

Fuel Model	Flame Lengths
3	6-10 ft
4	10-20 ft
9	4-10 ft
10	8-14 ft

The flame lengths above can be compared with data on the effectiveness of various suppression resources in Table 6-3. The rates of spread and flame lengths are grouped into four categories. The flame length

groupings conform to the values used in fire behavior charts (Rothermel 1972), which reflect the ability to succeed at fire suppression as indicated.

Comparison of the predicted flame lengths with Rothermel's data shows that change of vegetation from fuel model 9 (open stands with little understory vegetation) to model 10 (stands with a great deal of understory vegetation) greatly increases the flame lengths and suppression difficulty. Longer flame lengths (which indicate higher intensity) also increase firefighter risk and damage to vegetation and soils. Without human or natural disturbances, the majority of areas in the closed conifer litter fuel model (model 9) will progress into the conifer litter with understory model (model 10). This higher hazard fuel model presents the potential for higher rates of spread, longer flame lengths, and crowning situations. Given late fire season weather situations, this would result in a stand-replacing wildfire. This scenario presents the long-term need for large area fuel treatments in combination with strategically placed fuelbreaks.

Table 6-3. EFFECTIVENESS OF FIRE SUPPRESSION FOR FIRES OF VARIOUS INTENSITY

Fire Intensity	Rate of Spread	Flame Length	Effective Suppression Resources
Low	0 to 10 ft/min	0 to 4 ft	hand crews
Moderate	11 to 50 ft/min	4 to 8 ft	hand crews with motorized equipment
High	51 to 100 ft/min	8 to 12 ft	aerial suppression
Extreme	100 + ft/min	12 + ft	all suppression efforts ineffective

Air Quality

Air quality is influenced by fire disturbance events within the Upper Main Eel watershed. The Federal Clean Air Act, as amended in 1990, requires all federal agencies to comply with federal, state, and local air pollution requirements. Criteria pollutants emitted from or formed as a result of prescribed fire include particulate matter (of special health interest is PM 10, those airborne solids 10 microns or smaller in size), oxides of sulfur and nitrogen, carbon monoxide, and ozone.

Weather patterns strongly influence air quality and smoke management by controlling the dispersion of emissions from fires. The primary weather conditions that affect dispersion are atmospheric stability, mixing height, and transport wind speed. Prescribed burns are conducted when transport winds are not expected to carry emissions to smoke-sensitive areas in quantities that affect Prevention of Significant Deterioration increments and visibility. Prescribed burning activities are coordinated with the state and the appropriate air quality management district to ensure that atmospheric stability and mixing heights are conducive for dispersion.

Wildfires in northern California have created heightened emission events. Narratives about the large 1936 wildfires mentioned dense or drift smoke obscuring the fire location. The 1987 and 1994 fire events resulted in reduced air quality over large geographical areas.

6.6 Future Trends

Plant Communities

Human uses of the resources in this watershed continue to evolve. Although the mix of beneficial uses of the vegetation in this watershed in the future is unclear, some likely components can be identified. There is likely to be increased value and manipulation of vegetation to produce desired fish and wildlife habitat conditions. The value of vegetation for aesthetics to facilitate recreational use of the Upper Main Eel watershed should increase. This will include wilderness use as well as water-oriented downstream uses. Plant communities and vegetation mosaics that provide stable ecosystems will likely be established and maintained. This type of ecosystem will reduce the chance of catastrophic fires that put lives and private property at risk, and require the commitment of public resources. Vegetation that supports high yields of quality water for on-site and off-site use will be maintained. Production of forestry commodities at sustainable levels should continue.

The data presented in Figures 6-4 through 6-7 may indicate that it is desirable to change the distribution of seral stages to promote ecosystem stability, economic return, and habitat value. Specific project analysis will determine the appropriateness of manipulation on any specific area, but some generalizations can be made. In order to perpetuate disturbance-dependant grass and brush vegetation types, disturbance (either planned or unplanned) is necessary. A short cycle is needed for grass types, perhaps 5 to 15 years. A 15- to 30-year cycle is required for brush. Over the next fifty years, approximately 1000 acres of hardwood stands in early seral stages would need to be created to obtain a more even distribution of early and late seral stages. This could occur through natural or human-implemented disturbance events. Soil conditions may exist that will not allow an exactly even distribution of seral stages to be achieved.

There appears to be a shortage of older, multi-layered vegetation and poles and saplings in the mixed conifer vegetation type. Seral stage distribution in this vegetation type seems to be heavily weighted toward mature, single-layer forests and seedlings/saplings in the watershed. Activities that protect and encourage the development of multi-layered vegetation and encourage the movement of young, single layer forests into later seral stages should achieve a more balanced representation of the various seral stages of mixed conifer vegetation within the watershed.

Disturbance Patterns

The future disturbance patterns in the watershed will depend, to a large degree, on the management actions taken now and in the future. Disturbances will continue to occur.

Continuation of Existing Fire Disturbance Regime

Continuing the current practices of aggressive fire suppression will result in periodic stand replacement fire events at a rate of approximately 18,500 acres per decade (1,850 acres/year). These events will largely be unpredictable as to timing and scale. Stand replacement would average approximately every 120 years for most of the forest in the watershed.

To make a projection of expected future disturbance events, a risk assessment was made. The following formula was used to calculate risk, based on the number of starts, number of years of historical information, and the number of acres involved:

$$[(x/y)*10]/z = \text{risk rating, where}$$

x = number of starts recorded for chosen area,
y = period of time records cover, and
z = number of acres analyzed, displayed in thousands.

Considering the total number of fires that occurred within the Upper Main Eel watershed, the risk rating is as follows:

$$[(797/83)*10]/188 = 0.51.$$

These data project approximately one fire every 20 years per thousand acres.

Proposed Disturbance Regimes

The alternative to unplanned, high-intensity wildfires is systematic, prescribed treatments including prescribed burning, thinning, harvesting and, perhaps, prescribed natural fires. In order to materially reduce the intensity of wildfire events, a significant increase in the number of acres treated per decade would need to occur. Table 6-4 summarizes the average levels of disturbance on national forest land that would be necessary to approximate historic disturbance patterns. The proposed average disturbance frequency (86,780 acres per decade, or 8,680 per year) mimics our estimate of the historic average disturbance frequency (Skinner pers. comm.). It should not be inferred that the numbers presented as the average disturbance frequencies are absolute numbers. As with any natural system these averages are the midpoints in a range. In the case of disturbance frequencies, it is reasonable to expect ranges of -50% to +100% to exist. To establish desired diversity, prescribed disturbances should strive for a distribution around the average.

Table 6-4. PROPOSED DISTURBANCE REGIMES FOR THE UPPER MAIN EEL WATERSHED

Vegetation Types	Proposed Ave. Disturbance Frequency	Total Acres	Acres per Decade
Conifer-Hardwood	15 years	37,700	25,130
Grass and Savanna	8 years	4700	5880
Hardwoods	10 years	15,900	15,900
Knobcone Pine	30 years	10,400	3470
Red Fir	60 years	700	120
Chaparral	25 years	33,600	1340
Mixed Conifer	20 years	69,880	34,940
Total Disturbance			86,780

Future suppression actions will continue to be aggressive unless the Forest's Fire Management Action Plan indicates that alternative strategies would be beneficial for hazard reduction. Decommissioning of roads could increase fire sizes by increasing arrival times, but at the same time it would decrease access, which could reduce the number of human fire starts.

Air Quality

Increased use of fire for ecosystem management may increase the number of planned emissions that cause intrusions into populated areas and wildernesses. This is especially possible during underburning when it is difficult to vent smoke because of the low-intensity burning required to protect the standing trees (FSEIS 1994). The nearest communities to the Upper Main Eel watershed are many miles away and prevailing winds help ameliorate air quality concerns. Emissions from wildland areas need to be viewed in the context of total emissions over time. We can adjust the proportion from wildfire events versus prescribed fire events, but not the total quantity of emissions. Planned ignitions and prescribed natural fire events can be timed to take advantage of favorable weather conditions. The emissions that occur in these cases will not contribute to the unmanaged, and probably untimely, emissions from wildfire events.

7.0 ISSUE 5--ECONOMIC OPPORTUNITIES

7.1 Issue Statement

The Upper Main Eel watershed has the potential for providing employment opportunities through resource management and restoration activities. There has been an overall reduction in commodity outputs and a resultant loss of employment opportunities in recent years. The Upper Main Eel watershed contains 20 percent of the Forest area and has matrix land which in the President's Plan was identified as land where commodity outputs can be obtained on a sustained basis. This watershed is expected to provide opportunities to carry out restoration, achieve sustainable timber production, and support regional tourism and the recreation service industry, thereby enhancing community stability through increased employment.

7.2 Desired Conditions

The watershed contributes to the economic well-being of nearby communities by providing resource management activities, restoration activities, commodity outputs and direct employment on the Forest.

All resource and output activities are sustainable and based on ecologically sound principles that maintain or improve the watershed.

Out-year planning allows the public to see what level of commodity outputs can be expected.

Quality recreation experiences which benefit the service industries in the surrounding counties are provided.

7.3 Key Questions

What resource enhancement opportunities exist to provide commodity outputs and local employment opportunities while providing for a healthy ecosystem, meeting ACS objectives, and following the Standards and Guidelines in the ROD? (See Sections 7.6, 11.1, and 11.2.)

How can recreation development and maintenance contribute to local employment? (See Sections 7.6 and 9.6.)

What level of, and schedule for, timber production can be expected, while still providing for a sustainable ecosystem? (See Sections 7.6 and 11.2.)

What opportunities exist to enhance community economic conditions? (See Sections 7.6, 9.6, 11.2, and 11.3 and Chapter 12.)

What is the value of the Eel River water to urban and agricultural users in the Russian River basin? (See Sections 7.5 and 7.6.)

7.4 Past Conditions and Processes

[Unless otherwise cited, historical information in Sections 7.4 and 7.5 is adapted from Supernowicz, 1995.]

Settlement Patterns and Demographics

American Indian Use

The Upper Main Eel River was a focal area for the local American Indian economy. Three primary groups are identified as occupying portions of this watershed: the Yuki, Huchnon, and the Pomo. The Yuki and Huchnon are associated with the Eel River watershed. Pomo territory is generally considered to be around Clear Lake and Potter Valley. It has been estimated that population densities consisted of five to seven persons per square mile in the Coast Range (Lewis in Anderson 1993). Potter and Gravelly Valleys were areas of intensive activity. Gravelly Valley was a permanent node for the surrounding area; from there, resources could be collected and traded in and across the surrounding range.

American Indians selectively altered the natural landscape to suit their social and economic needs. To help in their hunting and gathering the American Indians used fire to alter the local landscape in settlement areas. Fire was used to clear undergrowth, improve browse for wildlife, increase acorn yield, and allow for easier travel across the landscape. American Indian dependence on vegetative resources was highly diversified, with numerous plant species utilized for a broad range of food and non-food products.

It appears that indigenous people's resource use in pre-contact times was sustainable. Tales of famine were rare, at least among the Yuki, indicating an adequate resource base over time for the subsistence of existing populations in the watershed. During the 1850s, practices of the indigenous people changed as they were introduced to Euro-American methods of hunting, trapping, agriculture, and animal husbandry. By the 1870s, the traditional patterns of annual migration and food collection in the area were dramatically altered. During post-contact times the Yuki relied upon ranchers and the government to get them through a harsh winter. (Chapter 6 addressed fire and vegetation as related to American Indian activity.)

Euro-Americans

It has been estimated that there were 4,000 American Indians living in Lake County prior to the arrival of Euro-Americans. The first Euro-Americans within the watershed were hide hunters and trappers. Unlike the mining areas of California, the Upper Main Eel watershed remained relatively unchanged through the latter part of the 1850s, with bear, deer, and other fur-bearers present in large numbers. In the absence of widespread mining and prior to a dominant grazing industry, hide hunters played an important role in the local economy during a period when hide hunting in most areas of California had lost economic importance. The hide-hunting period was short-lived; the grizzly bear was exterminated and elk were nearly exterminated by the 1870s.

The general pattern of Euro-American settlement within and around the Eel River basin was clearly established by the 1870s. Congressional authority in the 1850s and 1860s allowed legal land acquisition by Euro-American settlers. Passage of the Homestead Act in 1864 allowed settlers to gain legal title to lands squatted in the 1850s. By the time the Forest Reserves were established in the early 1900s, most of the agricultural land within what is today the Mendocino National Forest had been used for grazing, preempted, or homesteaded.

Most homesteads were comprised of 160- to 640-acre parcels which included water sources and glades. Virtually all remote homesteads included small orchards and gardens. Food grown by homesteaders was supplemented by hunting game and trapping. Homesteaders in the area of the Forest were more self-sufficient than homesteaders on more accessible lands. However, the scattered rural population needed

locations where they could market their products and purchase staples they could not produce themselves. As Hullville developed in response to this need, Gravelly Valley continued to serve as an economic node for the Upper Main Eel watershed. During the winter and heavy spring snows, high water and rock slides stopped all transportation into and out of the valley for weeks at a time. The small community of Hullville, located in Gravelly Valley, served as the northern node for an intensively used network of grazing driveways extending south to Bartlett Mountain. Grazing activity decreased after several hard winters in the early 1900s killed large numbers of animals. Hullville ceased to exist in 1921 when Scott Dam was built and Lake Pillsbury covered the town-site.

Fisheries

Fisheries were an important resource in the American Indian economy. The Eel River and its tributaries were a valuable fishery for all three local groups; it was often contested between the groups, and sometimes fought over. Anadromous runs in the watershed offered both salmon and steelhead. Indigenous people built small weirs across streams and used baskets to harvest fish. Natural plant chemicals were used to stun fish in low-water pools. This fishing activity may have affected the timing and size of the runs, although use of ritual to support harvest timing and limitations may have minimized fishing impacts (Swezey and Heizer in Anderson 1993). Salmon runs in the Upper Main Eel watershed contributed to the support of populations as far away as the Sacramento Valley. Indians from the Valley crossed the range in large numbers to catch and dry Salmon Creek (Gravelly Valley) fish for winter use.

During the 1870s and 1880s, a large canning industry existed at the mouth of the Eel River based on the fish migrating up the river each year. The salmon and steelhead migrating into the Upper Main Eel watershed contributed to this fishery. The Euro-American settlers in Gravelly Valley used the salmon, just as the American Indians used the salmon, as an additional food source in the fall and winter. These salmon runs were blocked when the Potter Valley Project was built in the early 1920s. For more information on the extent of the fishery refer to Chapter 3.

Grazing

The region's economy and natural ecology went through a major period of transition in the early 1870s, when livestock grazing increased in both area and numbers of animals. After the Civil War, a high tariff was placed on wool to keep out foreign competition. This made the wool industry very profitable for American producers. During the 1870s the "mountain men" of Mendocino County grew wealthy due to the increase in the price paid for U.S. wool. In 1879 Cloverdale shipped 692,215 pounds of wool to market. The wool trade moved to Ukiah when the railroad was extended there.

Grazing pressures increased within the watershed due to rapid population growth and demand in the Bay Area. There was also a demand for beef in the lumber camps along the coast, and mutton was shipped as an inexpensive substitute for beef. Due to increasing demand and coyote predation, by 1900 many sheep ranchers had switched to cattle. While sheep predominated west of the Eel River, cattle came to predominate to the east. Cattle were driven to the railroad in Ukiah where they were shipped to Bay Area markets.

Grazing pressures peaked in the 1880s. Thousands of sheep and cattle were grazed on land that would later become National Forest. Sheep were driven from the lower valleys into the higher regions for summer pasture. When the sheepmen left the mountains in the fall many would set fire to any vegetation not used by the livestock. This would cause vegetative sprouting which would be available for grazing the following year. As a result, most areas of the forest were overgrazed and burned during the 1880s and into the early 1900s. Gravelly Valley itself, however, and the areas extending along the South and Rice Forks, were not intensively used for grazing, primarily because they were private lands. Sheep and cattle introduced and spread many foreign plant species. At certain locations, such as the areas located on some of the higher ridges, there has

been a permanent reduction or loss of vegetation, with an accompanying loss of grazing value. According to several early accounts, these now-barren areas were originally covered with thick grass, brush, and vines.

Although grazing was a significant activity in the area for over 100 years, a decline of the vast ranches in the montane areas of Lake County began in the 1890s. In addition to the decline in forage outlined above, severe storm winters decimated livestock in that decade. The impact caused by unrestricted grazing was one of the reasons for the creation of the National Forest in 1907. In the 1920s the second-largest group of Forest grazing permittees resided in Potter Valley, indicating continuing important grazing revenues to the valley from areas on and around the Upper Main Eel watershed. As late as 1925, grazing was the greatest single source of revenue on the Forest, exceeding all other resource revenues.

Timber Harvest and Roads

Prior to 1920, timber within the Forest was usually harvested by small operators. Timber harvest in the Upper Main Eel area started in the 1850s when loggers established mills just above the valley floor along the front range of the mountains. Logging moved further into the watershed in the 1860s when a wagon road was built from Potter Valley to an area north of Horse Mountain and then on to the north side of Elk Mountain. Denison Mill was established on the northwest side of Horse Mountain. Later, from 1875 to 1890, the Elk Mountain Sawmill was located north of Elk Mountain. A second sawmill was established on Elk Mountain in 1882. These mills and a Sanhedrin Mountain mill established in 1895 sent lumber to Potter Valley where it was used to support the growing community. Another road was established from Elk Mountain down Middle Creek and on to Upper Lake. This road carried lumber to the Clear Lake communities.

Other sawmills located outside the Upper Main Eel watershed also sent lumber to Potter Valley. Although many of these early mills could be moved, early logging was limited to the mountains closest to communities because mill sites were tied to roads or other transportation. Logging was probably conducted within a 5- to 10-mile radius around the mills. As the easily accessed old-growth stands of timber were cut over, the sawmills were relocated further east to areas of old-growth forest or areas selectively cut in the nineteenth century.

By 1905, timber mills on the west side of the Coast Range had proliferated. Inland lumber firms shipped their products to markets almost entirely by railroad. A narrow-gauge railroad was built from near Elk Mountain down to the Scott Dam area. The lumber shipped down this railroad was used for the construction of Scott Dam.

It was not until the 1920s that the Pacific Southwest Region of the Forest Service began to exploit the timber resources of the Forest. Logging is tied to forest road access. In 1925 most of the Forest's timber was still considered inaccessible. It was not until after World War II that the remaining virgin stands of timber at the higher elevations were harvested.

Forest road miles increased greatly during the Depression of the 1930s in the greatest road-and-trail-building episode on the Forest. The Civilian Conservation Corps (CCC) built many of these roads and trails between 1933 and 1941. Their activities had three important results: establishment of a basic road system within the Forest, access to many more timber stands, and employment of otherwise jobless workers from throughout the country.

As part of the nationwide Emergency Conservation Work program, participants in the CCC, the Works Progress Administration, and the smaller "Local Experienced Man" programs fought wildfires, built firelines, and cleared brush on the Forest throughout the Depression. CCC crews also revegetated meadows and planted thousands of young conifers. However, only the small "Local Experienced Man" program was restricted to employing local residents and therefore immediately benefited the local communities, according to Mendocino National Forest Archaeologist Greg Greenway (pers. comm.).

Due to market collapse in the Depression, logging was not an important activity within the Forest during the 1930s. During and after World War II large trucks were available to use the new road system. This resulted in an increase in timber harvest from the Forest. Major congressional appropriations for road construction to support timber harvest occurred in the late 1950s and 1960s. The increased logging activity in the watershed was indicated by the amount of activity in the Corbin Creek drainage, where over 68 MMBF of timber was harvested from both public and private lands between 1955 and 1963. By the mid-1960s the increased harvest was also having a noticeable impact on the watershed.

Figures 7-1 and 7-2 show an estimate of the volume of timber harvested from the Upper Main Eel watershed by the Upper Lake and Stonyford Ranger Districts since 1967. Approximately 55 percent of the Upper Lake and 30 percent of the Stonyford timber volume came from the Upper Main Eel watershed during this time.

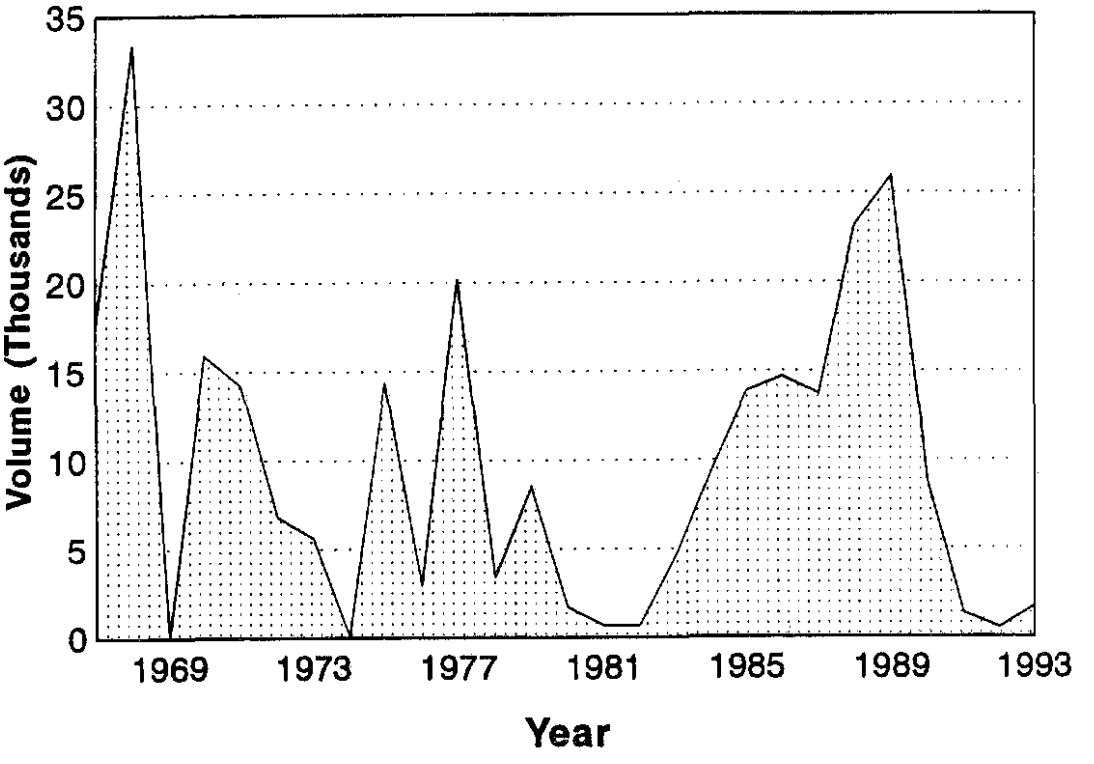

Figure 7-1. Volume of timber harvested from the Upper Main Eel watershed by the Upper Lake District.

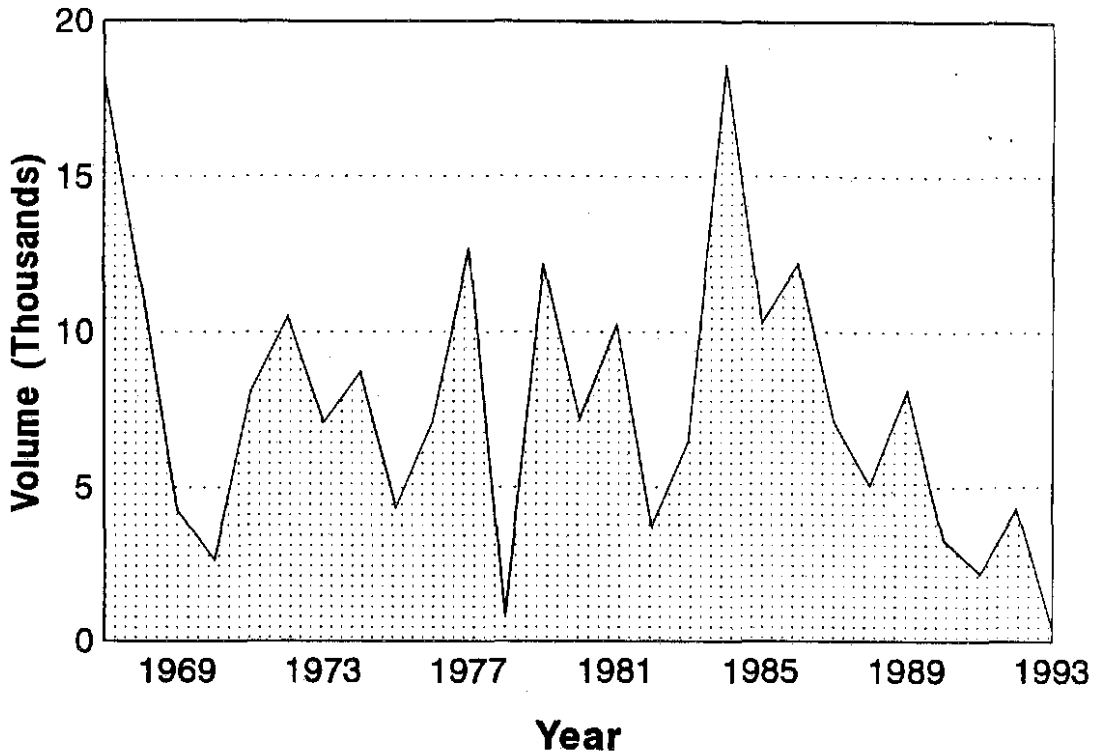

Figure 7-2. Volume of timber harvested from the Upper Main Eel watershed by the Stonyford District.

One of Potter Valley's largest employers for many years was the Louisiana Pacific sawmill at Van Arsdale. Saw logs for this mill came from Louisiana Pacific's own land, other private land, and National Forest land, including the Upper Main Eel watershed. When sufficient quantities of local logs were no longer available for harvest, sawlogs had to be trucked in from long distances. This increased the total operating costs of the Potter Valley mill, and was a factor in making it non-competitive with mills in Willits and Ukiah that are closer to Highway 101 and a railroad. The Van Arsdale mill was closed in 1992 and the operations relocated less than 30 miles away in Ukiah, where increased efficiency could be achieved.

Water Development

Preservation of the watershed was the primary reason for recommending the Stony Creek Forest Reserve, today the Mendocino National Forest, into the National Forest System: "This reserve must be created chiefly on the ground that it is the headwaters and watershed of streams that will some day be developed for irrigation" (USDA 1906). The intense livestock grazing of the nineteenth century had degraded the watershed, despite the numerous, small-scale, early water developments such as log troughs created to preserve local water sources.

Building and completion of Scott Dam as part of the Potter Valley Project spurred economic development in Potter Valley and the Russian River basin. In the 1910s and 1920s, electricity was a relatively new and expensive commodity, with demand for electricity increasing at a very fast rate. Electricity from the Potter Valley project covered most of the costs of building the Dam and operating the project. A local source of hydroelectric power lowered the cost of power to local communities and was a source of revenue for local owners. The Pacific Gas and Electric Company purchased the Potter Valley Project in 1929 from the original owners. The design of the project resulted in water being diverted from the Eel River into Potter Valley. This

benefited Potter Valley by providing a reliable source of irrigation water which spurred agricultural development. Excess water not used for irrigation is allowed to flow down the Russian River for downstream uses.

Recreation and Tourism

As grazing forage declined in the 1890s, recreational opportunities in the Main Eel watershed began to be promoted outside the region. National travel magazines such as an 1893 issue of Overland Monthly carried accounts of camping opportunities in the area. During the same decade, development of recreation-related resorts and spas in more accessible, adjacent areas of Lake County helped support tourism and recreational use of the southern Coast Range (Lake County 1995).

During the 1910s, thousands of fish were planted throughout Lake and Mendocino Counties. By the 1920s, Clear Lake and other lakes and reservoirs in Lake County were being promoted as sport fishing locations, often on the basis of introduced fisheries. Clear Lake, for example, was touted as the "Bass Capital of the West" (Lake County 1995).

The building of Scott Dam and the formation of Lake Pillsbury created new recreational opportunities while obliterating old ones: Scott Dam at Lake Pillsbury cut off the Gravelly Valley spawning areas, reportedly some of the best spawning areas in the entire Eel River system, while Lake Pillsbury, created by the dam, offered a more remote and "wild" landscape for lakeside recreation than the existing, developed lakes in easily accessible foothills areas. See Chapter 9 for further discussion of recreation and development in the Lake Pillsbury basin.

Watershed Restoration

The Mendocino National Forest was created to "protect the headwaters and watershed of streams that will some day be developed for irrigation" (USFS 1906). Some of the first actions by the Forest Service were to restrict grazing on the Forest. Later the Forest provided watering troughs to better control grazing by helping to disperse the animals. During the Depression, as noted above, many jobless men found work in the Forest doing conservation projects such as building roads and trails, fighting fires, clearing brush, revegetating meadows, and planting thousands of trees.

Watershed restoration and conservation projects continued after World War II. Many of these project were restoration projects following major fires. The Penny Pines project on Elk Mountain and the reforestation project after the 1987 fires are examples. Another example is the seeding and planting of native grasses in meadows areas of the forest. These restoration projects provided employment to many part-time workers and contractors.

7.5 Current Conditions and Processes

Settlement Patterns and Demographics

Today, 84 percent of the Upper Main Eel watershed lies within Lake County; 10 percent is within Mendocino County, while 6 percent is within Glenn County. Colusa County borders the southeast side of the watershed. Access to the watershed is usually from the west side, with arrival most often via the access roads to Lake Pillsbury.

Potter Valley is the permanent community closest to the watershed. Some Potter Valley residents are dependent on agriculture and timber while others commute to other cities and towns for employment. The Gravelly Valley area, within the watershed, has few permanent residents. Most housing units located in

Gravelly Valley are used as vacation and weekend retreats. A seasonal population increase occurs when the weather improves in the spring and summer and people move in for the season.

All four counties in and around the watershed have unemployment rates higher than the state average, according to data supplied by the California State Employment Development Department (1993). Since the 1970s, Lake County's unemployment rate has been 2-4 percent higher than the state unemployment rate; the unemployment rate in 1993 was 13.8 percent (CSEDD 1993). Sixty percent of Lake County's population between the ages of 16 and 64 are in the labor force: the statewide average is 67 percent. At the same time, between 1970 and 1990 the population of Lake County grew rapidly from 19,548 to 50,631. Services and retail trade dominate the job market, with much of this employment tied to tourism. Agriculture and forestry comprise 7.7 percent of Lake County employment (CSEDD 1993).

The combination of a relatively small labor force with relatively higher unemployment in a county experiencing strong growth appears to indicate several factors in employment. First, the county may have a relatively high number of retirees and/or individuals who choose not to work. It is possible that, were more attractive jobs available, some percentage of this group might choose to work. Second, while the county has experienced rapid growth, some employment sectors may not have benefited from its growth. Third, most arrivals since 1970, who now comprise the majority of the county's population, have continued employment outside the county, brought their jobs to a new site, or created or generated their own employment.

Mendocino County has had an unemployment rate slightly higher than the state's; the county unemployment rate in 1993 was 12.0 percent (CSEDD 1993). According to the 1990 Census, 62 percent of Mendocino County's population 16-64 years old are in the labor force. Between 1970 and 1990, the county's population grew from 51,101 to 80,435 (Horner 1995, based on 1990 U.S. Census data). Mendocino County may be experiencing the employment trends described above at a slightly slower rate. In 1990, farming, fishing, and forestry provided 2,744 jobs in the county (Horner 1995). Over half of the county's manufacturing jobs are tied to timber.

The eastside counties of Glenn and Colusa are mainly agricultural counties within the Sacramento Valley, and as a result they have high seasonal unemployment rates tied to agricultural employment. The 1992 unemployment rate for Glenn county was 19.5 percent, and the 1993 unemployment rate for Colusa was 20.1 percent (CSEDD 1993).

Fisheries

Scott Dam blocks anadromous fish from reaching the upper portions of the watershed. This has reduced the fishery resource from its historic levels, and recreational and commercial fisheries have been impacted. The Potter Valley Project has affected salmonids by altering the flow regime below Cape Horn Dam during the fall and spring, and downstream migrating salmonids have been lost into the diversion into the Russian River (see Chapter 3).

These impacts have been in part offset by fishery and recreational benefits in the Russian River. In addition, Lake Pillsbury and the regulated flows in the river between the two dams provided a new recreational fishing resource that has become a destination for many people. The majority of use comes from people living in the North Bay area. There is a recreational trout fishery in the upper watershed and between the two dams, and a trout and warm water fishery in Lake Pillsbury (see Chapter 9).

Grazing

Grazing activity within the Forest has been greatly reduced from its historic past. At the present time, eight of the 27 grazing allotments on the Forest are totally or partly within the Upper Main Eel watershed. See Section 8.5 for additional information on current grazing conditions.

Timber Harvest and Roads

Approximately 53,000 acres of conifer forest exist on National Forest land within the Upper Main Eel watershed outside of wilderness and late successional reserves. Of that, approximately 46,000 acres is typed as tentatively suitable for production of wood products, based on the criteria in the Proposed Land and Resource Management Plan for the Mendocino National Forest (the LRMP). A reduction of approximately 60 percent from this figure is necessary to reflect reductions to the land base available for wood product production due to riparian reserves. Further reductions are necessary to account for the estimate of unmapped late successional reserves (LSRs) and green tree retention standards and guides from the ROD. These reductions result in approximately 15,000 acres available for wood product production in the Upper Main Eel watershed. Using the current average growth rate from the Proposed LRMP of approximately 210 board feet per acre per year for the Forest, net growth of wood fiber on land identified as suitable for production of wood products in this watershed is approximately 3.2 MMBF.

Timber harvest jobs are available to those living in Glenn and Colusa as well as Lake and Mendocino Counties due to road access to the timber resources located on the east side of the watershed. Much of the timber cut along the east side of the watershed is sent to mills in Oroville and the Redding area which are outside the local counties. The timber cut around Lake Pillsbury area (Upper Lake Ranger District) is usually sent to mills in Mendocino County or other north coast counties.

There are approximately 760 miles of roads within the watershed, many of which need annual maintenance. Many of the roads have failing culverts, and some need to be reconstructed to minimize erosion. Approximately 4 percent of the 1995 Forest budget is allocated to road maintenance. Much of the maintenance is achieved through the work of local contractors, cooperators, permittees, and timber purchasers.

Water Development

The water diverted from the Eel River into the Russian River basin through the Potter Valley Project plays a major role in supporting agricultural and municipal uses in the Russian River drainage (Beach 1995). An estimate of the value of this water can be made by considering the value the California State Department of Water Resources established for its water bank water. During the drought the water bank cost was as high as $125 per acre-foot (Department of Water Resources 1992). The 1994 water bank cost was $50 per acre-foot (J. Pacheco pers. comm.). The volume of water diverted from the Eel River to the Russian River varies from year to year, depending on rainfall. During 1993, a slightly above normal water year, 178,200 acre-feet of water was diverted. In dry years less than 150,000 acre-feet is diverted. Multiplying the per acre-foot water costs by the volume of water diverted results in an estimated approximate value of $7-18 million per year. These figures do not take into account the additional value of the water in supporting the agricultural and urban communities of the Russian River basin.

Recreation and Tourism

Tourism can be considered a commodity like others produced by the watershed. Today, areas around the Upper Main Eel watershed are marketed for tourism primarily on the basis of their scenic landscapes and outdoor recreation potential. Lake County promotes itself as a "water wonderland" of lakes, reservoirs, fishing,

and mineral and hot springs (Lake County 1995), while neighboring Mendocino County is part of a "Redwood Empire" promoting vineyards, valleys, and forests (Redwood Empire 1994). In addition, local history and cultural traditions and livelihoods related to natural resources are important aspects of promotion: fishermen, loggers, and farmers are noted in tourism publications along with artists and artisans. The Coast Range of the Mendocino National Forest is an important backdrop for scenic tourism in these areas.

Sport fisheries are a major aspect of Lake County's tourism program, and are an important economic commodity throughout California. Although the value of recreational fishing within the watershed has not been established, in 1992 recreational fishing in California supported 154,000 jobs, with personal income impacts of nearly five billion dollars. The California industry additionally contributed 2 billion dollars in sales, with value-added impacts of 5.7 billion dollars (McWilliams 1994). Today, Lake County continues to market itself as the "Bass Capital of the West." Although it is not clear precisely how much of the regional job sector is generated by recreational fishing, in 1990 fishing, farming, and forestry generated 3,514 jobs in Mendocino and Lake Counties (Horner, 1994, based on 1990 U.S. Census data).

Within the watershed, recreational opportunities range from resorts to wilderness. Fishing, hang-gliding, motorcycle riding and competitions, boating, swimming, hunting, horseback riding, and hiking are specifically promoted by the Lake County marketing program as opportunities within the Upper Main Eel watershed. Service employment supported by these opportunities includes eleven fishing guides working within Lake County; over 50 hotels, motels, and resorts; 11 bed-and-breakfasts; and more than 30 parks and campgrounds in the County. Of these, one resort, one motel, and the campgrounds managed by PG&E and the Forest specifically support tourism to Upper Lake and the Lake Pillsbury area. (See Table 16.6-1 for a description of facilities in the Lake Pillsbury area.)

As discussed previously in this section, in the last two decades both Mendocino and Lake Counties have experienced strong growth rates. Along with the growth in these areas and the North Bay area and Sacramento has come increased use of the Lake Pillsbury area. The variety of recreational uses within the watershed has also increased. Off-highway-vehicle use and hang-gliding, for example, have become prominent activities.

Watershed Restoration

While the Mendocino National Forest has had many restoration projects over the years, the President's Forest Plan increases the emphasis on certain wildlife and fishery values. Funding is currently available on the Forest for projects that increase native fisheries and provide wildlife habitat.

7.6 Future Trends

Settlement Patterns and Demographics

The future settlement patterns within the Upper Main Eel watershed are not expected to change much from the present conditions. Most of the housing units in and around Gravelly Valley are expected to continue to be used as vacation and weekend retreats. Probably the most important change in settlement patterns will occur outside the watershed.

Projections for Lake County's population indicate continuing strong growth to 88,800 residents by the year 2010. Mendocino County projections are also strong, indicating 116,700 residents by that time (Horner 1995). The Russian River basin is growing at a very rapid rate, with many residents moving into the Santa Rosa area. The Upper Main Eel watershed will likely become a close (less than two-hour drive) recreation destination for these residents. This will increase the recreation demand on the facilities around Lake Pillsbury (see Chapter 9). The Ukiah area is growing, and a number of people will likely be living in Potter Valley and commuting to

Ukiah for employment. The Lake Pillsbury area may become a local recreation destination for those living in Potter Valley. Rapid population growth within the Russian River Basin will increase the demand for water (see Water Development in this section).

Fisheries

The fish harvest in the Upper Main Eel watershed is mainly recreational, and focuses primarily on resident rainbow trout and warm water species such as largemouth bass and other sunfish. The anadromous fish population that uses the Upper Main Eel watershed is limited (see Chapter 3). Several projects have been proposed to increase the production of salmonid young. Any project which increased the number of juvenile and adult salmonids would provide a direct benefit to local and coastal communities by increasing their fishery base. The potential value of the recreational and commercial catch is very high, and as a result these communities have a direct interest in developing the best possible conditions for rearing salmon and steelhead.

Grazing

It is expected that grazing will continue at the present level, or decrease somewhat, into the future.

Timber Harvest and Roads

With the approval of the Proposed Mendocino National Forest LRMP, the acreages planned to emphasize different management actions will remain relatively consistent for the next ten years. Within this watershed, approximately 15,000 acres of land is planned for management that produces sustained yield of forest products.

The RAMPREP growth models used for development of the Proposed LRMP predict that a potential growth of approximately 535 board feet per acre per year can be obtained through intensive forestry practices. Using this figure, potential net growth on lands identified as suitable for production of wood products is approximately 8.0 MMBF in the Upper Main Eel watershed. For comparison, using purely a proportionate share of the proposed LRMP, a harvest level of approximately 4.5 MMBF (20 percent of the forest total) would occur in this watershed. Another comparison analysis was performed using average data from forest inventory information using approximate stand ages. This analysis predicted a yield level of approximately 4.2 MMBF per year.

Decisions to treat vegetation on specific sites, including those actions that result in harvest of forest products, will obviously be made following appropriate NEPA analysis. This watershed should be able to provide at least 3.2 MMBF of sustainable wood product harvest. Over the long term, sustainable levels of perhaps as much as 8.0 MMBF could be attained, depending on forestry practices that are implemented.

Whether all of this growth is available for timber harvest depends on the results of site-specific analysis. Limits may occur due to restrictions on road construction; needs for transpiration and root-holding material on slides (see Chapter 8); provisions to provide dispersal habitat in addition to that provided by riparian reserves, unmapped LSRs, and reserved areas; and the large quantity of young stands in this watershed. Harvest may aid the development of additional older forest ecosystems and increase forest health by taking advantage of thinning possibilities in the densely stocked young stands within the watershed. Key older hardwood components may be preserved within some conifer hardwood stands by removing conifers which over-top or crowd hardwoods.

Current models developed by the Forest's Land and Resource Management Planning Staff using models constructed by the Forest Service and the U.S. Department of Commerce for timber-related employment indicate that logging and milling by themselves typically require 3-6 person-years of employment per million board-feet processed. Given the timber harvest range outlined above, the Upper Main Eel watershed could provide 9-48 person-years of employment in milling and logging each year. Employment estimates on a statewide basis range between 10 and 20 person-years per million board-feet (USDA 1993d). Based on these estimates, total statewide employment generated from timber harvested from the watershed could range from 30 to 160 person-years annually. "As the trend toward increased timber utilization efficiency continues, employment generated per unit of timber processed is expected to decline" (USDA 1993d).

Reconstruction and/or decommissioning of roads may create new employment opportunities. If decommissioning or reconstruction of those roads with greater maintenance needs and lower utility does not occur, there may be increased maintenance needs (and costs) in the future.

Water Development

PG&E has indicated that in order to continue to operate and maintain the Potter Valley Project economically, it is currently exploring cost-sharing plans with downstream users. Should such plans fail, PG&E will then seek a buyer for the project (S. Bhattacharya pers. comm.).

Because the water that is presently diverted into the Russian River has a very high value to the residents in the Russian River basin, it is possible that the water agencies which use the Russian River water may become part owners or owners of the project. The water agencies would then likely become very active in the management of Lake Pillsbury and the Upper Main Eel watershed. With the increasing development of the Russian River basin, the demand for high quality water will only increase, making the Eel River water even more valuable. Diversion of additional water from the Eel River might be pursued.

In a letter from the Sonoma County Water Agency to "All Parties Interested in the Potter Valley Project" dated 19 January 1995, it is suggested that PG&E, if unable to sell the project, would initiate steps to surrender the project license and abandon the project. In such as event, an alternative means of providing water to this area would have to be found. One option might be to construct a desalination plant. The Marin Municipal Water District predicted an initial capital cost of $50 million, not including operation and fuel costs, for the first phase of a 5,000 acre-feet per year desalination plant, clearly a much more costly alternative to continued operation of the Potter Valley Project.

Recreation and Tourism

As strong growth in Lake and Mendocino Counties and local suburbanization to Ukiah continues, greater demands will be placed on the watershed to provide opportunities for recreation and tourism. Public emphasis on the watershed's scenic value will likely increase as nearby areas are more intensively developed, leading residents to turn to adjacent public lands for recreation and scenery. Concern for personal enjoyment, expectations of new residents and tourists attracted by the area's scenery and outdoor opportunities, and the market value of commercial and private investments based on local history, scenery, and "wildland" access, may bring increasing pressure for management to support these values. (See Chapter 13 for data gaps related to scenery management.)

Tourism marketing programs are also expected to continue to promote scenic landscapes, particularly as they relate to regional history. Such valuing will create continuing and likely increasing interest in local mountain landscapes, such as those within National Forest areas of the watershed, which appear non-industrialized and "natural." In this trend, scenic landscapes may become a valuable "scarcity commodity." Residents may begin to place increasing value on the scenic, rather than resource commodity, value of the

landscape. The same trend may be expected to apply to residential development within the Lake Pillsbury basin.

Visitors with no economic interest in the Forest will be concerned with management decisions which affect their particular use of the Forest. Recreationists vary widely in interests and values. Some seek a recreational experience which emphasizes solitude, self-reliance, and remoteness; they will tend to share a value system based on nonconsumptive uses and preservation. Others seek open spaces and challenging terrain where they can ride off-highway-vehicles or go hang-gliding. A third group of visitors arrives in the fall for the hunting season. These groups may have values and attitudes toward Forest management which are at odds with each other. Conflicts over management decisions may be expected among these groups, and at times between recreationists and those with economic interests in the Forest. See Section 12.1 for discussion of recreational management opportunities within the watershed.

Watershed Restoration

Contingent upon continued funding for watershed restoration, extensive opportunities exist in this watershed to provide economic opportunities through the implementation of future watershed restoration projects. Chapter 11 lists a number of restoration projects that are designed to improve watershed health. Section 12.1 lists additional management opportunities, which can be further developed at the project level. Many of these projects will require a significant amount of permanent, seasonal, and contract labor. These projects are also dependent on available funding.

Future funding for restoration projects is variable. Congressional appropriations for projects vary each year. Budget cuts to balance the federal deficit are likely to have some effect on our ability to implement projects with appropriated dollars. Certain types of restoration work can be funded under the Knudsen-Vandenburg Act through receipts from timber sales; the amount of money available for such work will be commensurate with the value of timber actually sold in the future. Other funds or labor donated by our cooperators will probably continue to be available for project work through the use of cooperative agreements.

8.0 ISSUE 6--EROSION AND SEDIMENTATION

8.1 Issue Statement

Erosion in the Upper Main Eel watershed has affected the characteristics of many stream channels and impacted water quality in Lake Pillsbury and water for associated downstream uses. Water quality is important for recreation, anadromous fisheries, wildlife, water storage in Lake Pillsbury, and downstream agricultural and municipal uses. Sedimentation occurs from fires, landslides, and other land-disturbing activities such as roads and trails, vegetation management, grazing, and recreation. In addition, the Upper Main Eel watershed contains soils with clays which stay in suspension for extended periods of time, resulting in high turbidity in Lake Pillsbury and downstream waters.

8.2 Desired Conditions

Management of the watershed maintains and restores water quality and sediment regime to meet Aquatic Conservation Strategy (ACS) objectives (See Section 16.2).

A transportation plan exists for this watershed that minimizes erosion and sedimentation from roads and trails.

8.3 Key Questions

What actions can be taken to reduce the sediment yield from roads? Has the postponement of maintenance projects increased the risk of erosion and sediment yield? (See Sections 8.4, 8.5, 8.6, 10.6, 11.2, and 14.4.)

Are there roads and trails which can be closed and decommissioned? (See Sections 8.5, 9.6, 10.6, and 11.2.)

What types of projects, such as the Soda Creek project, can be undertaken that will enhance riparian conditions? (See Sections 8.5, 8.6, and 11.1.)

Where are the unstable soils and landslides and what actions can be taken to control their movement? (See Sections 8.4, 8.5, 8.6, 10.5, and 16.5.)

What were the historical conditions surrounding grazing, fire, and timber harvest in relation to sediment production? (See Sections 8.4, 8.5, and 8.6.)

What are causes of turbidity in Lake Pillsbury and in the Eel River below Scott Dam? Are there actions which can reduce the turbidity? (See Sections 8.4, 8.5, 8.6, and 16.5.)

8.4 Past Conditions

Conditions Related to Erosion

Bedrock Weathering and Soil Formation

Many factors control bedrock weathering, including climate, biological activity, and bedrock composition. The climate within the Upper Main Eel drainage basin is dependent on elevation and location: the lower elevations are warmer and drier while the higher elevations are cooler and wetter. Many local features also influence weathering of bedrock, such as slope, aspect, wind, rainfall, and temperature ranges. The increased moisture and cooler temperatures at some locations results in a heavy growth of conifers and an accumulation of organic matter on the forest floor. The acids produced from the decomposing organic matter will leach down

with the groundwater and attack the underlying bedrock. The different types of bedrock will react to these organic acids to become the source material for a wide variety of soils.

Some of the factors which control soil formation, such as vegetation cover, elevation, aspect, slope, and bedrock geology, are also factors that control rates of erosion. Erosion, by definition, is the removal and movement of both coarse- and fine-grained material, with the vast majority of the material being soil. Descriptions of the major soil units and subunits within this watershed are included in the USDA Soil Conservation Service's Soil Survey of Lake County 1989 (SCS 1989). Descriptions of the soils include slope data and erosion potential. The Forest Service has an erosion hazard rating which is different from the Soil Conservation Service hazard rating. The Soil Conservation Service rating system was developed in the Midwest for agricultural lands which are nearly flat and unprotected by vegetation. The Forest Service hazard rating takes into account the fact that a soil will be covered by vegetation for long periods of time.

A list of the soil types in the Upper Main Eel watershed, including their slope, Forest Service hazard rating, and area, is presented in Table 16.5-1. Soils which are deep, have low slopes, and are quick draining are given low hazard ratings. Most soils found on normal mountain slopes are given a moderate hazard rating. Areas that are known to have problem soils that tend to slump and slide are given a high hazard rating.

Soils with high hazard rating cover 83,919 acres (40.3 percent of the watershed). Soils of moderate hazard rating cover 117,932 acres (56.7 percent of the watershed) while soils of low hazard rating cover 6,207 acres (3.0 percent of the watershed). A high hazard rating is usually the result of some physical condition. As an example, the Okiota-Henneke soils which are derived from serpentine bedrock contain a high amount of montmorillonite clays. Montmorillonite clays are expanding clays which will creep and slide as they go through the seasonal wet-dry cycles. The Okiota soils also have nutrient problems that limit the variety and quantity of plants that grow on them. Without a thick plant growth any soil material that does develop is washed away. Another group of soils with high hazard ratings are the soils of the Mayman group. These soils form on graywacke bedrock, a combination of quartz-rich beds with shale beds. The soils produced from this bedrock are filled with quartz gravel held together by clays. When the clays become saturated with the winter rains they lose strength, causing the soil to slump and slide.

Landslides

Nearly one-sixth of the area of the Upper Main Eel watershed is prone to landsliding. The rapid uplift of the Upper Main Eel drainage has caused the deep entrenchment of many watershed rivers and streams. The down-cutting streams will create an over-steepened condition on the slopes next to the streams, causing soils and slides to move toward the stream. The slopes next to the streams with the most stable bedrock will form the steepest slopes and the narrowest canyons, while the areas next to the streams which are prone to sliding will form the lower more moderate streamside slopes.

The various metamorphosed rocks within the drainage react differently to uplift forces and the action of organic acids, and therefore have different likelihoods of sliding. The fine-grained quartz sandstone and chert sediments which were metamorphosed into a fine-grained massive quartz are very resistant to both physical and chemical weathering and are therefore less likely to slide. The lavas that were metamorphosed into greenstones (such as the areas around Snow Mountain) are also fairly resistant to physical and chemical weathering and not likely to slide. Shales, which are metamorphosed fine-grained silts and clays, have good structural strength at depth, but with uplift and reduced overburden pressure a large number of fractures and joints form, penetrating 50 to 100 feet into bedrock. These fractures and joints along with old faults allow for deep entry of surface water and organic acids. When the surface water and acids interact with the shales they rehydrate and soften, resulting in many areas prone to sliding (see Section 16.5).

Properties that increase slope stability include the soil's inherent natural strength, cohesion, and root support forces. Forces that reduce slope stability include: (1) anything increasing slope, such as stream and road

undercutting; (2) groundwater conditions that contribute to seepage, pore-pressure, and uplift forces; (3) planes of weakness, including joints, fractures, faults, and rock foliation; (4) localized weight increase, caused by road fills and water saturation; and (5) removal of vegetation, which causes loss of root support and the reduction of groundwater dissipation through evapotranspiration.

Some forces that encourage slides and soil creep are beyond human control. Planes of weakness controlled by bedrock geology such as joints, fractures, faults, rock foliation and composition cannot be controlled. The slow down-cutting of streams which oversteepens streamside slopes is also beyond human control.

Other actions are within human control, such as road construction and vegetation manipulation. Vegetation management can be considered in part soil support management, due to the action of plant roots. Also, vegetation will control the rate at which soil water is dissipated through evapotranspiration.

High groundwater has the potential to trigger slide movement. When high groundwater occurs pore pressure will increase within the slide, causing a reduction of the slide's internal friction. Water entry into the basal slip surface will exert an uplifting force which will also reduce internal frictional forces. Many rotational and translational slides will develop depressions on their surface, some of which will contain ponds. As a result, water that enters these depressions will percolate slowly into the slide, encouraging movement. There is often a delay of months to years between the time the water enters the top of a slide and the time it takes to reach the main body or seeps from the bottom of the slide. The delayed release of water from slides can have major benefits in maintaining summer stream flows.

Slides will result in large volumes of material being deposited directly in stream channels. When the toe of a slide reaches the channel, it is typically a heterogeneous mass of various-sized material ranging from large boulders to fine clay. The water within the channel immediately starts to erode and move material downstream; the rate and the size of the material moved is dependent upon the volume of water flowing in the channel. Water will act as a size-sorting medium, with the coarse material becoming bedload and the finer material going into suspension and remaining suspended as long as high turbulent flows are maintained. Over time stream erosion at the toe of a slide will set up a condition under which the slide can be activated; the rate of erosion determines the approximate length of time before activation occurs.

Roads and Trails

The original transportation system within the watershed consisted of trails originally used by American Indians to travel within and across the forest. These same trails and some new ones were built by the ranchers to move to the high summer pastures. The number of road miles increased greatly during the 1930s when the Civilian Conservation Corps (CCC) built many new roads within the Forest (Supernowicz 1995). Many of the CCC-built roads became the backbone of the present transportation system. During and after World War II large trucks became available to effectively use the new roads. This resulted in an increase in logging activity from the 1950s on. Most logging operations require reasonably close road support, so as the demand for timber increased, more roads were built within the Forest.

The roads were often wider than needed for logging, to allow public access to the Forest. The design standards for roads in the 1950s and 1960s did not minimize the input of sediments into streams. Many of the roads built in the 1950s and early 1960s were not designed to withstand large rainfall events. The road builders were unaware of the presence and extent of many unstable areas, resulting in many roads failures during subsequent floods.

Grazing and Fire

Both grazing and fire have led to loss of vegetive cover within the watershed. Healthy vegetation holds soil in place and slows erosion processes. Without vegetation, the soil is subjected to direct raindrop impact and washing by heavy rains. The roots of healthy trees and brush provide significant support by binding the soil to bedrock, which will slow or stop slide movement. Also, vegetation will remove water by evapotranspiration, which in turn will help stabilize slides by reducing the pore pressure.

Grazing in the watershed reached a peak in 1870-1900 when many thousands of animals were driven into the mountains for summer pasture (see Section 7.4). The stockmen used fire extensively to modify the vegetation to produce feed for their animals (Supernowicz 1995). Heavy grazing and burning led to an altered and reduced vegetation cover on large areas of the watershed. Without protection, the A-horizon of the soil in many areas was eroded by the winter rains, creating large barren areas on many of the higher ridges. Grazing controls in the Upper Main Eel watershed started shortly after the Mendocino National Forest was created in 1907. The practice of burning the forest and brush to produce feed by herdsmen ended with the creation of the Forest. Over the years increasing controls have been applied to grazing activity within the Forest.

Wildfires have also had a significant effect on vegetative cover in the watershed. In the last 80 years more the half of the watershed has burned at least once. The 1987 fire season was particularly severe, with several large, high-intensity fires occurring within the watershed. Substantial areas of forest were burned along with considerable areas of chaparral. Plant nutrients released by these fires were washed into Lake Pillsbury, leading to higher than normal turbidity in Lake Pillsbury the following year due to more algal growth. Increased erosion appears to have occurred in several subwatersheds due to these fires. (The effects of fire on vegetation in this watershed was discussed in detail in Chapter 6.)

Erosion and Sediment Transport

Channel Morphology

Channel conditions, such as stream gradient and canyon shape, affect a stream's ability to discharge water and carry sediment. Generally, low-gradient reaches are sites of sediment deposition, while high-gradient reaches are usually sites of streambed scour with only coarse gravels and cobbles in the streambed. The channel morphology is determined by flood events; only during a flood does the river have the energy to move large boulders and cobbles along its bed. It is during a flood that a channel bed form is developed. The pool and riffle bed form is caused by the river dissipating its flood energy by increasing bed roughness. The pool and riffle bed form is also caused by the river carrying mixed bedload material ranging from pea to watermelon size (Knighton 1984). Over a long period of time a river reaches an equilibrium. A river is in equilibrium condition, stable and graded, when the river's ability to carry sediments is equal to the material being delivered to the river. If the river's ability to transport sediment is less than the sediment arriving from upstream side channels and slides, the channel will aggrade (build up with sediments). When a river's ability to transport sediments is greater than the sediment supply, the river channel will degrade (erode sediments and lower the channel). In the Upper Main Eel watershed, sediment will arrive in the channel from side channels, erosion of unstable banks which are often the toes of slides, and sheet and gully erosion of surrounding slopes. In the Upper Main Eel watershed, many active and dormant slides are located next to channels with higher channel gradients.

General stream channel morphology is controlled by the large flooding events. Flooding may occur only a few days every few years, but these few days will define the channel characteristics until the next flood. Occasionally there will be an extremely large flood that defines channel characteristics for decades following the flood.

Floods and Streamside Vegetation

Three major flood events had a significant impact on the watershed. They are the 1862, 1955, and the 1964 flood events. All indications from sediment studies in the Eel River delta show that the 1862 event was a very large flood. The 1862 flood event occurred at a time when the upper basin was just starting to feel the impact of white settlement; the watershed in 1862 closely represented conditions as the Americans Indians left it. From subjective evidence it appears that the riparian vegetation and fish stocks survived the 1862 event with little long-term damage. After the 1862 flood, the fish runs returned to a level which supported a fishing industry at the mouth of the Eel River.

There were a number of smaller pre-1955 floods which occurred during the period of watershed overgrazing. Runoff from the barren areas and the high meadows carried away a large quantity of fine-grained topsoil, leaving behind a rocky subsoil. Most of the finer material probably passed through the drainage downstream to the Eel delta, since eroded fine-grained soil material usually remains in suspension during turbulent flood flows.

The two other large flood events occurred in 1955 and 1964 (California State Department of Water Resources 1982), and while we don't have data specific to the Upper Main Eel watershed, we do know that these two floods were very damaging in other parts of the Mendocino National Forest and other national forests located in northwestern California. Floods are the most important events when it comes to eroding and transporting sediments. Brown and Ritter (1971) showed that over half of all the sediments that moved in the Eel River basin during a 10-year period did so in the highest 3 days of flood flows in the 1964 flood. When a channel aggrades during a flood it will often rip out most or all the riparian vegetation.

It is not possible to directly assess sediment movement caused by past floods; however, the presence or absence of riparian vegetation can be used as an indicator of past sediment movement. A lack of vegetation may indicate heavy sediment movement, and a decrease in vegetation over time may indicate that the channel was cleared of vegetation by floods and is possibly aggrading due to increased sediment.

Aerial photographs taken in 1941 prior to, and in 1993 subsequent to, the major floods in this watershed both show little riparian vegetation present along the Main Eel River, Rice Fork, and Soda Creek. The main Eel River above Lake Pillsbury to Corbin Creek had very little associated vegetation in 1941, as did Rice Fork from Lake Pillsbury to Blue Slides Creek. Soda Creek had little vegetation in the two miles above Eel River. Thus, one cannot conclude that the lack of riparian vegetation in these areas is a result of flood damage. This raises some interesting questions: Was there riparian vegetation along these rivers and streams before 1850 when only American Indians occupied the region? If so, is the later lack of vegetation the result of natural processes other than floods? Did the period of heavy grazing and burning from 1860 to 1900 cause the change? Did the riparian vegetation get cut for firewood and other uses when the first ranchers moved into the region? We are unable to answer these questions at this time.

Sediment Deposition

Deposition into Lake Pillsbury

Lake Pillsbury is a sediment trap for all the coarse-grained and much of the fine-grained sediments that erode from the drainage above the lake. This is a natural process that will, in time, fill the lake. Porterfield and Dunnam (1964) studied the rate at which sediment is filling Lake Pillsbury. Their analysis showed that the original storage capacity of the lake was reduced from 94,400 acre feet in 1921 to 86,780 acre feet in 1959. This represented a loss of 8.1 percent of capacity. A second study was completed in 1984 (Brooks et al. 1984) and showed that the capacity of the lake was 80,700 acre feet. This represents a loss of 14.8 percent of the lake's capacity since 1921. The rate of sediment filling was slightly higher in the second period but this period

included the very large 1964 flood. No firm conclusions can be made about changes in the rate at which the sediments is being deposited in the Lake Pillsbury from these two studies.

Lake Pillsbury is not intended to be a flood control project; as a result peak flood discharges occur downstream of the dam. These high discharges sweep away the course-grained gravels in the river channel downstream of Scott Dam. Since Lake Pillsbury acts as a sediment trap for all the larger-grained sediments coming from the upper watershed, there is no replacement gravel coming from upstream. This could be a problem if a large numbers of anadromous fish were to return and need spawning gravels (see Section 3.5).

Turbidity

Turbidity has been identified as a water quality problem in Lake Pillsbury which also affects downstream agricultural and municipal users. The Potter Valley project (described in Section 3.5) was developed primarily as a power project. The water diverted from the Eel River into the East Fork of the Russian River benefited the agricultural land owners in Potter Valley, with all the excess water going into the main Russian River. The excess water is very valuable to downstream users along the Russian River. (A rough estimate of the value of this water is presented in Section 7.5.) Coyote Dam on the East Fork of the Russian River was built, in part, to store some of the diverted water. Unfortunately the diversion of Eel River water into the Russian River basin has adversely affected certain uses in the Eel River drainage. Turbidity in the water tends to detract from its value because of increased treatment costs. Turbidity also lowers the visual quality of the water.

A major cause of turbidity is the presence of fine-grained clays which are produced from the weathering of the naturally occurring bedrock within the basin. Montmorillonite and kaolinite are formed by the weathering of volcanic bedrock. Volcanic bedrock underlies large areas along the east and north sides of the drainage, and serpentine (a metamorphosed iron-magnesium rich plutonic rock) is found in the Bartlett Springs Fault Zone and in scattered patches throughout the whole drainage (see Section 16.5). By volume, montmorillonite totals about 30 percent and kaolinite about 40 percent of the total clays washed into Lake Pillsbury. The remaining 30 percent of the clays arriving in Lake Pillsbury are chlorite and illite (Brooks et al. 1984).

Montmorillonite is an expanding layered clay that has a charge developed within the layers and along the clay layer edges. The chemistry of the waters (concentrations of sodium and calcium, and the pH) determines how quickly these clays will settle out of solution. The waters from naturally occurring thermal springs, in combination with photosynthetic activity, will produce high pH conditions in the deeper waters which tend to keep montmorillonite in suspension for very long periods of time (see Section 16.5). Kaolinite, illite and chlorite have very fine sheet structure so any turbulence tends to keep them in suspension. These clays need a fair amount of time in non-turbulent water to settle out.

The amount of clay which settles out in a reservoir is dependent on its natural shape and how the reservoir is operated. As noted by Ritter and Brown (1971), the most turbid water is discharged from Lake Pillsbury during the fall when the lake is drawn down to its lowest levels. At that time the sediments that have been previously deposited on the lake bottom are exposed and can be eroded by the tributary streams and fall rains. When the lake remains at low levels, very turbid water will be discharged.

When the reservoir refills in the winter it is filled with turbid water. In the spring, cool water from the tributaries tends to slip under the warming lake surface waters, causing a slight turbulence in the deep water. This turbulence keeps some of the clays in suspension. The narrow channel of Rice Fork which discharges near Scott Dam will keep the deep water in this area turbulent. In the late spring and summer a high pH condition develops in the deeper waters of the lake, which keep the montmorillonite in suspension. Even with a water chemistry that keeps the montmorillonite clays in suspension there is a slow clearing of the deep waters in summer due to the settling of other clays. Late spring through fall water discharge from the lake is from the stored deep water which contains the suspended clays. By fall the lake is drawn down to very low levels, exposing large areas of lake bottom to erosion.

Another source of turbidity and sediments is the washing of the Lake Pillsbury shore by wind-caused waves and boat wakes. When a reservoir is first formed the waves on the surface will wash the soil on exposed slopes. The erosion will be very severe during the first few years; after a number of years, however, waves will have washed away the easily erodible material and left a resistant subsoil, bedrock, or gravel lag at the shoreline. Little further erosion will occur. The material that is eroded will be washed downslope or, if it is fine grained, will go into suspension and settle out on the lake bottom or along the low sloping shore lines. Lake Pillsbury was formed by damming in 1921 and the lake has had time to form a reasonably stable shoreline. The turbidity that develops around the edges due to wave action is probably the result of resuspension of sediments that were deposited on the shoreline during the previous winter's high water.

The volume of soil lost due to shoreline erosion since 1921 was estimated at 100 acre-feet (Brooks et al. 1984). A new survey is probably not required to check shoreline erosion because little change is expected to have occurred since the prior survey. A new survey might be needed if there is a change in the way the lake is operated, especially if the lake levels were to be increased.

8.5 Current Conditions and Processes

Conditions Related to Erosion

Best Management Practices

The Forest Service is guided by a number of laws and regulations that emphasize the protection of soil and improvement of the water resources on National Forest System land, including Best Management Practices (BMPs) and Cumulative Watershed Effects analysis (CWE). These are used to plan, examine alternatives for, prepare work plans for, and make follow-up audits of all land-disturbing activities on the Forest.

Best Management Practices were developed by the Forest Service to guide activities on the forests, with the objective of slowing erosion and reducing the movement of sediment. The State of California through the State Water Resources Control Board has instituted regulations to protect the quality of the state's water. Due to the size of the land base and the number of projects on National Forest land, an agreement was signed with the State Water Resources Control Board designating the Forest Service as the land management agency to control non-point sources of pollution on their own land. This agreement directed the Forest Service to follow its own BMPs as closely as possible. The State Water Resources Control Board can and does conduct reviews in the national forests in California and makes spot checks of Forest Service activities.

The recommended BMPs cover most land-disturbing activities that occur on the Forest. The activities covered by BMPs are timber harvest, road building, construction, mining, recreation, vegetation manipulation, fire suppression and fuels management, grazing, and more general watershed management. The BMPs give instructions as to how to plan and prepare a work plan which examines the alternatives, describes how to implement the BMPs, and provides instructions on follow-up examinations to see how the BMPs worked. The BMP process has been in place since 1981 and can be credited with reducing erosion at many locations in the Forest.

Cumulative Watershed Effects Analysis

It was recognized that if too many projects occurred in one area the cumulative effects of all the projects would be deleterious to a watershed even when the BMPs were closely followed. Cumulative Watershed Effects (CWE) is a program which is used by the Forest Service to determine if a subwatershed is likely to become a problem. A CWE analysis is performed on every proposed project that has the potential to increase the sediment yield from any area of the watershed. The whole watershed is broken into small subwatersheds for analysis. The analysis quantifies the effects of different project alternatives and identifies when cumulative

effects exceed the "threshold of concern," indicating that too many activities may have been concentrated within the watershed. All disturbances on both private and national forest lands within each subwatershed along with the miles of roads are considered in the analysis. The area and effect of past, present and planned disturbances are analyzed. The disturbances are then examined in relation to the most recent Stream Channel Stability Evaluation, an evaluation of channel and riparian conditions performed under the direction of the forest hydrologist.

There are several subwatersheds that have a combination of national forest and private ownership. When the private owner plans a timber sale, the area and the methods used may result in that subwatershed exceeding the level of concern. As a result of activity on private land, the Forest Service may delay certain activities on land within the subwatershed. The CWE analysis forces all planned activities such as timber harvests and pre- and post-harvest treatment to be considered along with the miles of roads. The Forest Service policy is to keep all subwatersheds below the threshold of concern.

The Forest Service has been doing CWEs and stream evaluations for a number of years. The Stream Channel Stability Evaluation teams have been picking up a general improving trend along most stream channels. This would indicate that using BMPs and CWE analysis during project planning and implementation has reduced erosion within the Forest. Watershed conditions have also improved through the Watershed Improvement Needs (WIN) program. Watershed improvement projects have occurred on meadows, barren areas, landslides, and roads.

After the 1987 fires, several subwatersheds exceeded the threshold of concern. A variety of grasses, forbs and tree seedlings were planted to speed up the process of revegetation. Studies have shown that when trees are removed from an area, it takes approximately 20 years after establishment of seedlings for the forest to return to its original soil-holding capacity and evapotranspiration levels. In the case of a burned brush field, the time needed to return to the original soil-holding and evapotranspiration capacity is seven years, in part because many brush species will resprout after they are burned. It has been seven years since the fires in the Upper Main Eel watershed and recovery is now occurring; although the recovery is not complete, all of the subwatersheds within the Upper Main Eel watershed are currently below the threshold of concern.

Landslides

Forest Service geologists have identified many landslides within the Upper Main Eel drainage. Landslides contribute a significant percentage of the total sediment discharged by the river. Most of these landslides were mapped using aerial photographs. Recent slides show fresh scarps, jack-strawed trees, displaced roads, and stream channels with large rocks in the channels. Dormant landslides have bowl- or spoon-shaped depressed areas and many old slides have well-defined flat lobes, depressed sags and ponds, water seeps, and water-loving vegetation. On long-dormant slides, a mature growth of trees will often hide the landslide topography from the aerial photo interpreter. In grassland, oak, and brush-covered areas, the detection of slides is very difficult because grass and brush can reclaim disturbed areas quickly. As a result, the most recent slides are usually identifiable while many of the older sides elude detection. This is a problem when making land planning decisions. Inner gorge areas are also areas of concern because the oversteepened side walls of the gorge can result in sudden large slides. Identified slides cover 20,646 acres of the Upper Main Eel watershed, or 9.3 percent of the watershed. The unstable inner gorge along watercourses covers 16,083 acres, or 7.2 percent of the watershed. A total of 16.4 percent of the watershed is classified as unstable.

Studies by Kelsey (1988 and 1980) on Redwood Creek and Van Duzen River, on the northern California coast, showed that only a small number of slides contained the majority of the slide volume which delivered most of the large-sized bedload material to the river and stream channels. Because of similar geology, the same relationship is expected in this drainage.

A sediment budget indicating the source of sediments has not been prepared for this watershed. However, Kelsey (1978, 1980, 1988) has done several studies and has helped prepare several others for California north coast rivers and streams. The 1988 study of Redwood Creek shows that over 35 percent of the material arriving in the stream channels comes from slides, while over 60 percent of the material arriving in stream channels is derived from the erosion of colluvium and soils along low-order streams draining upper hillslopes. These low-order streams usually carry fine-grained clays and sand, while slides deliver a mixture of coarse gravels, boulders, sand, and clays to larger channels.

The current Forest policy for slides and unstable areas is to limit activity on identified slides and unstable or potentially unstable areas. Active intervention has occurred on some slides in an effort to slow and control their movement. This policy has protected and/or reduced sliding on many unstable areas. In addition, the ROD has included unstable and potentially unstable areas in the riparian reserves, where special standards and guidelines apply.

See Section 16.5 for additional discussion of slides.

Roads and Trails

A properly designed and maintained road is a valuable forest transportation asset; however, an improperly designed and maintained road can be a contributor to river and stream channel sediments. Any failure on a road within a riparian area will usually result in sediments being washed directly into a channel. A road, by its nature, is a relatively horizontal flat barren strip which often has many cuts and fills on hillslopes. By cutting across slopes, roads will disrupt and intercept the normal downslope movement of percolating soil water. Often the intercepted soil water is added to the water draining from the running surface and carried to the nearest natural drainage. This change in drainage will increase peak flood flows and the number of floods in the small drainages receiving the water. The higher, more frequent flood events in the small drainages will increase the erosion along those drainages.

There are approximately 760 miles of roads within this watershed, including 167 miles of roads with surfacing material, usually crushed rock or gravel. There are 531 miles of unimproved roads which have native soil surfaces and an estimated 62 miles of roads of unknown quality. The roads of unknown quality are primarily temporary spurs adjacent to old timber sales. An estimated 70 percent of the roads in this watershed are insloped, causing funneling of water to small drainages.

Many roads are in or cross riparian zones and many also cross known unstable areas. There are 2.5 miles of roads on active slides and 68.6 miles of roads on dormant slides. When roads cross unstable areas they have the potential to reduce slope stability by cutting away a portion of the slide on the cut side and increasing the weight of the slide on the fill side. This change in weight distribution can be enough to start slide movement. Roads built on slides will often change the water distribution within the slides which can increase or decrease slide movement.

Many of the roads in this watershed were constructed to higher standards than their present and projected use warrants. They are not currently being maintained as was intended when they were constructed, however, and therefore may be contributing to erosion problems today. The culverts installed in the 1950s and 1960s may be undersized and are getting old and rusting out, and need to be upgraded or replaced. These culverts could fail in a flood event, resulting in the washing away of large volumes of fill. The culverts also need to be sized to pass woody and rock debris, and need energy dissipators to prevent downcutting and erosion of stream channels. Many of the old roads have insloped road surfaces, which necessitate cross drain culverts, and can cause washing of the inside ditches. Road maintenance needs can be quite high on the older roads, and as a result of lower maintenance budgets and less Forest Service personnel, maintenance on some roads has been deferred or is scheduled on a periodic basis. At the present time the Forest does not have a complete inventory of culverts and road surface drainage conditions.

The present OHV trail system consists of a combination of roads and specially designed trails. Many of the OHV trails are on Forest Service roads that were built for specific purposes and are now closed to larger four-wheeled vehicles. The roads are not decommissioned but are waterbarred, sloped, and graded to reduce the erosion hazard. Such roads which are not expected to be used in the future have been put into the OHV trail system. Specifically designed OHV trails have been built to connect portions of the road system and to take recreationists to portions of the Forest inaccessible by larger roads.

The running surface of OHV trails is smaller than the running surfaces of roads used by four-wheeled vehicles, but direct runoff still occurs from these trails and can lead to erosion. As with roads, OHV trails need periodic maintenance to keep erosion to a minimum. At the present time, maintenance on some trails in the watershed has been delayed, and as a result some problems may be occurring on these trails.

Point-source turbidity monitoring initiated in 1990 on two trails on the Neuns-Sanhedrin-Deadwood soil complex on Bucknell Creek have indicated that the location, design, and maintenance of these trails are compatible with dry-weather OHV use, and are an insignificant sediment contributor during storm events. Other trail sections, wet-weather use, and trails on other soil types and slopes, including those most vulnerable to erosion, have not been monitored. Undesignated use areas also have not been monitored. (See Section 14.4 for monitoring recommendations relating to this topic.)

District staff believe that most erosion on designated OHV routes occurs not on trails, but on the unimproved roads throughout the designated road-and-trail system. Highway-worthy four-wheel-drive vehicles are able to access these areas. Staff members believe that the much greater weight and road-contact surface areas of these vehicles contributes to increased intensity and scope of soil disturbance (N. Hamilton pers. comm.).

Motorcycle use outside designated areas during rainy or wet conditions may also cause soil disturbance. OHV-related damage to vegetation and soil through displaced soil and compaction is greatly aggravated when soil moisture exceeds 40 percent (USDA Forest Service 1980). On the other hand, a planned, well-maintained trail contributes almost no measurable sediment yield (USDA Forest Service 1976). Thus restricting use to planned trails, and maintaining these trails, is important in controlling sedimentation. Data on use outside designated trails and staging areas has not been located for this watershed (see Section 14.4.)

Most erosion-control construction in the Upper Lake Ranger District to date has been concentrated in areas south of the Upper Main Eel watershed. District management actions taken to reduce erosion from trails include annual maintenance, adding waterbars and sediment collection drains, rerouting steep sections of trails, constructing water crossings perpendicular to water flows with flat or gentle-slope approaches and exits, building superelevated curve-and-dip combinations, and minimizing transition areas where OHV tires will "bite" into the trail (N. Hamilton pers. comm.).

Grazing and Fire

There are eight grazing allotments that are all or partly within the Upper Main Eel watershed, including approximately 2,010 animal unit month's of grazing within the watershed. Grazing in the allotments starts in the late spring and ends in the early fall. Some of the areas that were barren after the period of overgrazing now have a vegetative cover, but the soil and amount of vegetation does not equal pre-contact levels. At the present time barren areas cover less than 1 percent of the watershed.

A detailed discussion of fire disturbance events is included in Chapter 6 of this report. The current fire regime of infrequent, high intensity fires will generate periodic but large increases in the amount of erosion and resulting sedimentation from fire events.

Erosion and Sediment Transport

Channel Morphology

There is usually little natural change in channel morphology on a year to year basis; when changes do occur they are associated with major events such as large floods and landslides. Certain land management actions can change the conditions along river channels, but the rate of change can be very slow. For example, if the rate of sediment input into a channel is reduced, the channel will tend to narrow and confine itself and cut down. The confining and narrowing process can be very slow because the process of confinement includes revegetation of the channel banks and the input of large woody debris. When a channel receives a sudden increase in sediments the channel will aggrade and often deposit the sediments in a wide flat plane.

Lower Soda Creek is an example of a stream that has a wide flat braided channel. The channel configuration is the result of excess sediments coming from upstream. There are many possible causes contributing to the excess sediments, such as old timber cutting in the drainage, road building, both natural and manmade fires, grazing in the upper drainage, and possibly excessive firewood cutting along the lower drainage. With better control on activities in the upper part of the drainage the rate of sediment transport should be going down. Instead of waiting for many years for the channel to confine itself by natural processes, certain actions can be taken to speed the process. One example of this is the Soda Creek Riparian Improvement Demonstration Project, a project designed to provide a confined channel, plant vegetation, and introduce large woody debris.

Floods and Streamside Vegetation

Flooding is a natural, unpredictable event. The winter of 1995 had above- average precipitation, and flooding occurred in the Eel River basin.

The strip of riparian vegetation along stream and river channels is a major site of interaction between physical and biological channel processes. (Biological aspects of riparian processes were discussed in Chapter 4.) The Eel River, Rice Fork, and Soda Creek continue to have deficient complements of riparian vegetation. The lack of adequate riparian vegetation along these channels affects sediment movement and water flow dynamics. Without streamside vegetation, water and sediments that reach the channels move quickly down the channels, where they are deposited in Lake Pillsbury or Lake Van Arsdale.

The Soda Creek project was designed to change the flat dry braided channel of the creek into a meandering confined channel. The flood waters in January 1995 cut through the project area, washing out some of the logs placed in the channel and burying many other logs. The desired condition of a naturally confined channel with steeper banks has been achieved. This new shape was caused by the flood waters acting on boulders and logs in the channel banks.

The present channel configuration might be maintained and improved by using boulder structures and planting vegetation which can withstand periodic floods and act as filters and trappers of sediments. Larger trees are needed along the banks to provide shade and a natural source of large woody debris to the channel.

Sediment Deposition

Deposition into Lake Pillsbury

Lake Pillsbury continues to trap all of the coarse-grained sediments arriving from the drainage above the lake. A spot study by Forest Service personnel in 1992 indicated that the rate of sediment filling is about the same as the 1959 to 1984 rate. The coarse-grained sediments which are arriving and settling out in Lake Pillsbury

are doing so in the tributary arms of the lake. The base of the sediment wedge deposited in the Rice Fork tributary is now approaching the base of Scott dam where the sediment has the potential of being swept through the outlet structure. The sediments from Rice Fork build toward the dam quickest when reservoir water levels are lowest in the fall and water flows are increasing with the fall rains. Although the lake is not at a critical point in sediment filling, actions by the Forest Service and private landowners can influence the rate at which coarse-grained sediments are delivered to the lake. There is obvious value in slowing the rate of sediment deposition and extending the useful life of the reservoir.

Turbidity

The turbidity that enters the Russian River from the Eel River has continued. This is due to the size of Lake Pillsbury and way the Potter Valley project is run. Studies comparing the weight of suspended sediment discharged to the volume of water discharged show that the water entering into the Russian River basin from the Eel is some of the cleanest water in the Russian River basin (Ritter and Brown 1971, Brooks et al. 1984). The problem is that the visual turbidity starts earlier in the fall than would normally occur in the Russian River and continues into the spring. The actual weight of the suspended sediment in the water diverted is fairly low.

8.6 Future Trends

Conditions Related to Erosion

Best Management Practices and Cumulative Watershed Effects

With continued use of BMPs to examine projects and CWE analysis to examine the subwatersheds, and continued watershed improvement work through the WIN program, the rate of erosion and sediment movement within this watershed should be reduced over time.

Landslides

By following the ROD and BMPs, the sediment coming from unstable and potentially unstable areas should be somewhat reduced over time. By taking a stronger proactive role it may be possible to greatly reduce the coarse-grained sediments coming from some large slides. The Six Rivers National Forest used physical structures and some channel modification to reduce deposition of slide material into channels (Furniss 1988). As noted in Section 8.5, it is expected that less than 1 percent of the land area in this watershed contributes more than one-quarter of the sediments in the main channels. Earthflows and slides are also the main source of coarse-grained gravels arriving in the channel. Therefore, implementation of a slide stabilization plan addressing some of the largest slides might greatly reduce the volume of coarse-grained sediments in the river channels within this watershed. (See Section 10.5 for a more detailed discussion of such a plan.)

Roads and Trails

A forest road will always have many cut and fill slopes and a compacted quick-draining running surface. By following the ROD, BMPs, and CWE, the sediment yield associated with roads should decrease. Because it is costly to conduct the maintenance and reconstruction on many of the roads in the watershed, the forest cannot afford to have roads that are not part of a well-thought-out transportation plan. Roads that are part of the transportation plan should be examined and reconstructed if necessary. Any roads not part of the transportation plan should be decommissioned. By following these guidelines and those in the ROD, it is expected that the sediment coming from roads will be reduced over time.

A well planned and maintained OHV trail system should should produce very little sediment. A good trail system would provide many hours of recreation to many users.

Grazing and Fire

Continued careful planning and monitoring of grazing should result in continued improvement of vegetative cover from the overgrazed condition that occurred in the later 1800s. Areas that are barren or poorly covered due to past grazing are potential sites for rehabilitation (see Section 11.2).

The long period of fire exclusion in this watershed has resulted in a high buildup of fuels in some areas. (This situation was discussed in more detail in Section 6.5.) If areas with a high buildup of fuels were to burn, the fire would be intense and destroy most or all of the soil-holding vegetation, resulting in a long period of elevated sediment deposition into the streams and rivers. It is preferable to have a number of lower intensity fires in which tree mortality is kept within manageable limits and the soil is held in place. Planning and implementing periodic burning may result in a slight elevation of sedimentation to the streams, but this alternative is preferred to the large intense fires that are likely to occur if current practices are continued.

Erosion and Sediment Transport

Channel Morphology

Controlling sediment input into streams and river channels will cause a slow change in the structural morphology of the channels. The continued use of BMP's and CWE should result in reduced sediment deposition in river and stream channels and in Lake Pillsbury. Changes to narrower, more confined channels will occur if coarse gravel and boulder input is reduced by management that decreases the movement of slides and earthflows.

Floods and Streamside Vegetation

The occurrence of flood events is unpredictable in terms of size and timing. We can expect future flood events with flows at least as high as the highest recorded floods of the past. Recognizing that these events are rare but naturally occurring disturbance events, there are actions that could be taken to mitigate the effects on the watershed that would otherwise be expected to result.

Restoration and development of healthy riparian vegetation along the rivers and streams would aid in restoring system resiliency in several ways. Riparian vegetation would slow the movement of sediment downstream by trapping and depositing sediments along the streambanks. Roots of plants in the riparian zone will bind to the soil, gravels, and rock along the channel banks, helping to stabilize and define the channel. The eventual establishment of large woody debris would slow water flow, trap sediment, and add structure to the channel.

Restoration of riparian zones will be a long process, taking several to many years to complete. Large winter floods will likely wash out some of the previous efforts, so riparian vegetation planting and channel structural improvements need to occur over several years. Establishment of healthy riparian vegetation will slow water and sediment movement outside the channel and contribute to stabilizing channel locations.

Unless active restoration efforts are successful, peak flows will continue to be higher than system capacity. These conditions will perpetuate frequent flood events and channel scour. Sediments will continue to move quickly from the source areas to Lake Pillsbury or down the Main Eel channel.

Sediment Deposition

Deposition into Lake Pillsbury

It may be possible to slow down the deposition of sediments in Lake Pillsbury and in the anadromous stream channels below Scott Dam by taking a proactive approach to slide control. Following the BMPs and CWE should help in reducing total sediment deposition.

Turbidity

The present turbidity conditions will likely continue into the future, since the cause of the turbidity is a combination of natural conditions that occur in Lake Pillsbury and the operation of the lake. The Forest Service can do little to correct the turbidity problem since the clays are the natural result of bedrock weathering. The high pH in the lake, which slows the settling of montmorillonite clay, is the result of natural springs and normal photosynthetic activity within the lake. The movement of fine-grained sediments out of Lake Pillsbury in the fall is the result of the drawdown of the lake. Changes in the amount of turbidity in Lake Pillsbury and downstream could occur if there are changes in the size and operation of the Potter Valley project. It may be possible to reduce some input of montmorillonite into Lake Pillsbury by carefully controlling activities on the Okiota-Henneke and Okiota-Henneke-Dubakella soils mapped by the Soil Conservation Service (USDA Soil Conservation Service 1989). The soils already carry a Forest Service high hazard rating, which limits activities in these areas.

9.0 ISSUE 7--RECREATION

9.1 Issue Statement

Values and expectations expressed by various recreational user groups within the Upper Main Eel watershed vary widely, and in some cases are not currently reconciled. Cumulative impacts from all recreational uses may not be consistent with the Aquatic Conservation Strategy set forth in the Record of Decision and with sustainable ecosystem management. Recreational uses of the watershed may result in resource conflicts with, for example, bald eagles and other threatened, endangered, and sensitive species, riparian reserves, and maintenance of water quality. Additional impacts might be expected in the event of future development around the lake and improved access to the Lake Pillsbury basin.

9.2 Desired Conditions

Recreational activities in riparian areas are consistent with the Aquatic Conservation Strategy objectives in the ROD.

Correlations between recreation and the area's eagle population are clearly identified and understood. Uses identified as incompatible with eagles are managed by type, location, season, or intensity to allow continuing participation and visitor satisfaction in established activities. Visitor understanding of, and compliance with, policies developed for sustaining bald eagle habitat supports viability of the area's eagles.

The Lake Pillsbury area continues to offer a wide range of recreational pursuits to the widest possible public. Protection of the area's natural systems, including its scenery, protects the existing economic value of private developments while improving recreational potential.

9.3 Key Questions

What is the carrying capacity for each recreational use in the watershed? (See Sections 9.5, 9.6, 13.5, 14.1, 14.4, and 16.6.)

How would improvement in road access change current trends in recreational use of the Lake Pillsbury area? (See Sections 9.6, 10.7, and 13.5.)

How can continuing and new recreational uses be accommodated in this watershed? How can OHV and other recreational uses be accommodated while enhancing the ecosystem? How can conflicts between user groups be minimized? (See Sections 9.6, 10.7, 12.1, and 13.5.)

How can recreational use be managed to allow attainment of Aquatic Conservation Strategy objectives? (See Chapters 4 and 8, and Sections 13.5, 14.1, and 14.4.)

How will meeting the guidelines of the Bald and Golden Eagle Protection Act and the Endangered Species Act as they apply to the bald eagles at Lake Pillsbury affect recreational use in the Lake Pillsbury basin? (See Sections 9.6, 10.7, and 12.1.)

What recreation-related issues should be considered as part of a management plan for the Lake Pillsbury area? (See Sections 7.6, 9.5, 9.6, 10.7, 12.1, 13.5, 14.1, and 14.4.)

9.4 Past Conditions and Processes

Recreational use in the Upper Main Eel watershed is most intensive in the Lake Pillsbury basin; therefore, this chapter of the analysis will focus on that area. Due to the variety of recreational uses in the watershed, and to the time constraints inherent in producing this report, the analysis in this chapter will be confined largely to those uses related to the desired conditions and key questions above. Concentration on these areas does not indicate that they are necessarily more or less problematic than other uses; rather, it indicates that they are pertinent to achieving desired conditions. Other socio-economic interactions within the watershed were discussed in Chapter 7 of this report.

Recreation and Development

Promotion of the recreational opportunities in the Upper Main Eel watershed began as early as the 1890s. (See Chapter 7 for discussion of the history of recreation in the watershed.) Significant development of the Lake Pillsbury basin began with the construction of summer homes on Graveyard Point and at Pogie Point Campground in the 1940s. A 1943 Forest recreation map indicated intensive recreational use on Graveyard Point, in the Pogie Point area, just west of the lake, and on private land on the Rice Fork. Fishing opportunities were shown on the upper Eel River, Salmon Creek, Corbin Creek, the Rice Fork arm, and on the Eel River below Scott Dam, although the types of fish were not indicated. Summer homes were shown scattered through the lower watershed.

Construction of the Graveyard Point summer home tract continued into the 1960s, with buildout at 71 homes. Sunset Campground was constructed in 1964. In 1986 the USFS permittee resort of Pillsbury Pines was razed; in 1986-1987 a number of facilities were constructed by the Pacific Gas and Electric Company (PG&E): Sunset Point Boat Ramp, Fuller Grove Boat Ramp, Fuller Grove Campground and day-use area, and Pillsbury Pines Day-Use Area and boat ramp. (See Chapter 16 for chronology and capacity of construction around the Lake). All of these facilities were constructed by PG&E under the FERC agreement and passed on to the Forest Service for management.

Lake Pillsbury Resort is on National Forest land and is authorized by a term Special-Use permit. The resort is composed of a campground, cabins, a store with fuel for boats and cars, and a boat launch. In addition to these facilities, PG&E owns 60 leased lots located on the west side of the lake. PG&E also operates Trout Creek Campground, a campground of 15 sites, approximately two miles east of the Eel River Bridge at Van Arsdale.

Past and present use levels and recreational activities are difficult to establish at the watershed level. Use level estimates for the Upper Lake District before 1965 are not known. Except for a few spot studies generated by specific proposals, the Forest Service has utilized Recreation Information Management (RIM) (between 1965 and 1986) and Recreation Resource Information System (RRIS) (from 1987 to the present) techniques to generate use level estimates for developed and dispersed recreational activities. Estimates are generated for the entire District. Site-specific estimates are made for developed or grouped sites in areas classified as "roaded natural," or for sites where further development is a management goal.

Both RIM and RRIS are derived from other estimates and/or sampling. Estimates may be generated from a number of sources, but do not require site and activity observations. However, in the absence of other data, trends in RIM and RRIS estimates have been used in this analysis in an attempt to identify trends in use levels. (See Chapter 13 for data gaps identified by this analysis.)

RIM estimates for developed sites in the area immediately surrounding Lake Pillsbury between 1967 and 1986 ranged from a low in 1968 to a high in 1978. Two sharp drops occurred, in 1974 and in 1977. Both of these may have been related to sudden increases in fuel prices; after both drops, estimated combined-use levels nearly doubled the following year and continued at the increased level.

Estimated surface use of Lake Pillsbury, such as diving, swimming, boating, water-skiing, and fishing, ranged from a high in 1978 to a low in 1981. Lake-surface use was estimated to suffer only one sharp drop, in 1977, when it dropped to less than half the previous year. This drop was also probably related to fuel-price increases. A 1986 peak-weekend flyover study found approximately 130 boats in the basin (PG&E 1986). The lake surface is owned by PG&E with responsibility for enforcement of lake-surface activities lying with the Lake County Sheriff's office.

Between 1977 and 1978 estimated use at the Oak Flat overflow area more than quadrupled. The reason for this is not clear. Variations in use estimates for other Forest Service campgrounds appear related to closures due to construction and other factors.

A 1986 Memorial Day PG&E vehicle count found 914 vehicles in the basin: 39 percent of total use occurred at the then-three Forest Service campgrounds, 11 percent occurred at Lake Pillsbury Resort, 28 percent was dispersed use around the Lake Pillsbury basin, and 13 percent was dispersed along the Eel River. Nine percent of the vehicles were OHV (probably four-wheel-drive), while 7 percent were motorcycles. Approximately 130 boats were within the basin. The study found that peak weekends produced approximately six times "normal" weekend use (PG&E 1986).

Dispersed uses have historically taken place throughout the Pillsbury basin. Around Lake Pillsbury, consultants have observed camping in undeveloped areas on the tip of Graveyard Point, near Horse Pasture Marsh, and near Swallow Rock.

Off-Highway and Other Motorized Vehicles

The terms off-road vehicle (ORV) and off-highway vehicle (OHV) will both be used in this analysis. The term OHV is currently in use, while ORV is a previous term used in earlier documentation. Both terms refer to motorcycles and all-terrain vehicles, and to four-wheel-drive vehicles.

Motorcycles have been used on the Mendocino National Forest since World War II, initially as a rapid means to reach remote areas. OHV use was not managed by the Forest until the mid-1970s, when a trail system for OHV use on the Forest was designated and began to be regulated. Special Use permits have been required for organized OHV events since the mid-1970s. Permits are not required for other types of OHV use.

A 1987 Forest Closure Order (No. 87-06) affecting some OHV use in the watershed was issued after the Mendenhall Fire to protect the public from unstable burned timber stands as well as to allow review and analysis of the area for rehabilitation. The order was not specific to roads and trails but was area-wide. The closure was terminated in 1989. Following termination of the closure order, the Upper Lake District has moved into more intensive management of its OHV program, designating its present trail system.

Bald Eagles and Recreation

Bald eagle nesting has been reported in the Lake Pillsbury area since before 1935: residents of the Forest Service summer home tract recall eagles in the tract area since its inception. Eagles have also nested within 800 yards of the Lake Pillsbury Resort. (A discussion focusing more on the biology of bald eagles was presented in Chapter 5.)

The bald eagle was declared endangered in 1967 (Federal Register 4001). Two primary documents have guided Forest management of eagles in the Upper Main Eel watershed: the Lake Pillsbury Bald Eagle Habitat Management Plan, Lake Pillsbury Nest Territory (USDA Forest Service 1979a), and the Recovery Plan for the Pacific Bald Eagle (USDI Fish and Wildlife Service 1986).

In 1979 biologists reported that boating activity on Lake Pillsbury did not appear to conflict with bald eagles, then nesting on Graveyard Point, due to several factors: minimal boating use prior to Memorial Day; summer water releases creating shallow water around the shore nesting area, which inhibited close approach by boats; the steep bank of the nest area inhibiting landing and hiking; and restricted overland entry to the nest area due to the need to cross private property. Many homeowners were also aware of the nest and tried to discourage use in the area (USDA Forest Service 1979a).

Recreational development has expanded at Lake Pillsbury since 1979 (see Section 16.6, Table 16.6-1). The location of bald eagle nest(s) has also changed several times since then. Given the estimates used to generate them, RIM trends cannot fully establish trends in visitation and use which could be correlated to eagle nesting in the basin. It is clear, however, that Lake and Mendocino Counties have grown rapidly since 1979 (see Chapter 7). This trend, coupled with the increase in facilities at the lake, may have increased recreational use at the lake since the completion of the Bald Eagle Habitat Management Plan.

Aviation and Gravelly Valley Airstrip

Gravelly Valley Airstrip is a single, unsurfaced, one-way runway which is on national forest land. It was built by private parties in the 1930s under a special use permit. Two hangars built by the original permittees have been removed. The southeast-northwest cross-runway still shown on maps has been closed for many years. The special use permit was relinquished in the early 1940s, and the airstrip received military use during World War II. Military survival training was based at the airstrip in the late 1940s-early 1950s. The Forest Service used the airstrip as an air tanker base in the 1960s. Occasional fixed-wing ambulance use and Forest Service administrative use continued until the early 1980s (USDA Forest Service 1991a). The geography adjacent to the airstrip's runway requires that planes land north and depart south.

The 1986 Memorial Day study observed more than 20 motorized aircraft and 40 hang-gliders in the area (PG&E 1986). After landing at the airstrip, visitors participate in camping, picnicking, and sightseeing in the area, and may stay a number of days before departing. RIM estimates from the 1980s indicate non-motorized aircraft activities, probably hang-gliding uses, nearly double those associated with motorized aircraft. Hull Mountain is a hang-gliding launch area. Launch sites are often accessed by OHV, at times in violation of route designation, according to District OHV Specialist Nora Hamilton (pers. comm.). Landings occur at areas around Lake Pillsbury.

9.5 Current Conditions and Processes

Recreation and Development

In 1995 the most recent construction phase at Lake Pillsbury will be completed with the construction of Fuller Grove Group Camp and Navy Camp. Under the FERC agreement, these campgrounds have been constructed by PG&E with management by the Forest Service.

Today recreation in the watershed includes camping, boating, fishing, swimming, motorcycle competitions and OHV use, hang-gliding, hiking, horseback riding, and second homes. Most of these uses are found in the Lake Pillsbury basin. Camping is estimated to be the most common form of recreation. Different types of day uses have different constituencies, although some users participate in several activities.

Lake County tourism materials describe "excellent trout waters" on the watershed, including Salmon, Smokehouse, Cold, Rice, Soda, Panther, Bucknell, and Rock Creeks, and the Eel River and the South Fork of the Eel. Several of these may be subject to closure by the California Department of Fish and Game as part of managing the fishery. (Further discussion of angling in the watershed was presented in Sections 7.5 and 7.6.) The Department stocks Lake Pillsbury with rainbow trout, and has introduced largemouth bass into the lake.

Bass, sunfish, salmon, and steelhead are promoted by the county as the sport fish opportunities in the watershed.

In the context of regional recreational opportunities, the Lake Pillsbury basin appears as a relatively remote, forested, wildland opportunity when compared to other lake-based recreation in the area. Clear Lake, the Blue Lakes, and Indian Valley Reservoir in Lake County, and Lake Mendocino in Mendocino County, are all available to recreationists from the North Bay and Sacramento areas. All offer alternative water sports and lake fisheries.

There appear to be several important differences between these opportunities and Lake Pillsbury. The other water bodies are all located in more accessible, less-forested, foothill areas, as opposed to Pillsbury's relatively remote, mixed-forest location directly beneath the mountains. In addition, other lakes in the area are either under extensive private development, like Clear Lake and the Blue Lakes, or are much more heavily used. For example Lake Mendocino, although comparable to Pillsbury in size, receives several times Lake Pillsbury's estimated use, with annual visitation of 1.2 to two million visitor-days, according to Noel Stoughton, U.S. Army Corps of Engineers (pers. comm.).

A fourth important difference between these lakes and Lake Pillsbury may be speed limitations for power boaters. There is no speed limit in effect for most of Lake Pillsbury, although the Lake County Sheriff's Office Boat Patrol does use buoys and patrols to enforce a five mile-per-hour speed limit within 200 feet of piers, docks, and landings, according to Lake County Sheriff's Office Boat Patrol Jack McMills (pers. comm.). In contrast, speed limits of 10 and 12 miles-per-hour apply on the entire Indian Valley Reservoir and the Blue Lakes, respectively (Lake County 1995). Tourism publications for lakes with speed limits describe them as "quiet" or attractive to sailors, paddlers, and trollers, indicating that the existence, or lack of, opportunities for speed boating may play a role in defining what groups are attracted to a lake site, and what their expectations may be. See Chapter 12 for management opportunities related to visitor expectations.

Off-Highway and Other Motorized Vehicles

Use

Over 175 miles of designated OHV trails currently exist on the Upper Lake Ranger District; the percentage of this amount within the upper Main Eel watershed has not been determined. Additional trails may exist outside the designated system; no estimate of their total mileage is currently available, according to Zone Hydrologist Les Gonyer (pers. comm.). Winter weekend motorcycle use averages roughly 150 motorcycles across the entire Upper Lake District, while on very busy weekends up to 400 motorcycles may operate across the District (Hamilton, personal communication). According to the Forest's existing Off-Road Vehicle Plan, the combination of topography, soils, vegetation, and climate on the Mendocino National Forest combine to produce an environment that is moderately fragile and subject to damage if improperly managed. At the same time it also produces a sizeable area that is well-suited to recreational use by ORV enthusiasts (USDA Forest Service 1979b). Throughout the Forest, four-wheel drive use is still heavily identified with hunting; however, individual and small group use is increasing, especially during the winter months.

Dispersed OHV use takes place on the watershed outside the Lake Pillsbury basin throughout the year. Use is heaviest on Sundays, with peaks on Thanksgiving weekend and President's Day weekend. During casual recreational use, when there is no organized event in progress, vehicles are allowed on designated routes only. Cross-country, or "open," riding is not permitted. Unimproved Forest Service roads in the designated trail system serve to link trails, since Forest Service policy in the Pacific Southwest Region allows unlicensed vehicles on unimproved (level 2) roads. All Forest Service roads which are part of a marked OHV route are maintained in the same way as designated trails.

The Lake Pillsbury basin is closed to all OHV use from 18 May through 8 September. Trails outside of the basin are open, and are officially accessed by "trucking" OHVs from the closed zone to the Powderhouse trail, although infractions against area and seasonal closures do occur. OHV users at times reportedly ride out directly from campgrounds, creating safety and noise concerns and potentially soil disturbances. Some OHV trails in this area lead to private property and contribute to trespass problems (N. Hamilton pers. comm.).

One-day OHV events are arranged under Special Use permits. Currently, the District holds two such organized events per year, which may be distributed over the Upper Main Eel and other watersheds within District boundaries. These are held the first Saturday in November and the Saturday after Thanksgiving. OHV clubs conduct the events and are responsible for compliance with the permits. Permitted vehicles include two-wheeled motorcycles and all-terrain vehicles with a maximum width of 48 inches.

OHV opportunities are offered at several areas adjacent to the watershed: in the Middle Creek area south of the watershed, on the Stonyford Ranger District on the Forest to the east, and at the Cow Mountain Recreation Area managed by the Bureau of Land Management, east of Ukiah.

Impacts of OHV Use

Noise

The noise of motorcycles is hypothesized to have potential impacts on wildlife, other Forest users, and adjacent landowners. Studies have thus far not led to useful predictions about the indirect physiological effect of noise on animals. At distances of 400 feet or greater, motorcycles which meet the State of California and USDA 101 decibel (dBA) limit will not cause sounds loud enough to impact the hearing of people. 1986 EPA standards for new motorcycles reduced allowable noise levels, to under 80 dBA for motorcycles of 170 cc or less, and 82 dBA for motorcycles of greater than 170 cc. Only motorcycles sold since 1986 have had to conform to these standards. Testing for National Forest motorcycle events is at the discretion of the Forest, and normally allows up to 101 dBA (USDA Forest Service 1993e).

Sounds produced by motorcycles ridden on typical OHV trails are detectable by observers listening for motorcycles at distances up to one-half mile (USDA Forest Service 1993e). Noise monitoring of an event by Upper Lake staff in 1992 under calm weather conditions indicated that there appeared to be no measurable difference in sound when OHVs were passing by at one-half mile versus when no OHVs were passing by. The human ear could distinguish the differences between the sounds, but the measured sound pressure level showed no difference. However, a sound source such as a motorcycle can be clearly audible above the background, in some cases, even though its measured sound level is below that of the background.

Sounds are known to carry emotional messages distinct from their decibel levels (USDA Forest Service 1993e). According to the Off-Road Vehicle Plan Alternatives report (USDA Forest Service 1979b), "unquestionably the strongest adverse reactions to off-road vehicles is caused by the...sound of a two-cycle engine....Noise has led to most of the efforts being made to restrict off-road vehicles." Such reactions may have been reduced by the 1986 reduction in allowable sound levels described above.

Traffic

All recreational uses on the watershed create traffic on its roads and trails. OHV roads and trails are open to all other recreational groups. OHV use, particularly all-terrain vehicles, is becoming increasingly popular among hunters. OHV disturbance of dispersed hunting campsites has nevertheless been a complaint made to the District. Potential conflicts exist between OHV and both equestrian and non-powered bikers. Use of unimproved roads by both motorcycles and four-wheel-drive vehicles creates a hazard both within and, at

times, outside the designated system. OHV use outside of the designated road-and-trail system has been reported in developed campgrounds at Lake Pillsbury.

Upper Lake trail designers strive to create trails which promote speeds of 15 miles per hour or less in order to alleviate both safety and sedimentation impacts. OHV riders are subject to traffic safety enforcement as are other motor vehicle operators. Part-time OHV patrol coverage is supplied for the system of designated trails. One of the most common types of accidents in OHV areas is collision due to undirected, two-way traffic; serious injuries are rare.

Erosion and Sedimentation

Although not conclusive, preliminary analysis conducted for this report indicated that erosion and sedimentation in this watershed due to OHV use are minor relative to effects due to roads, fires, and other causes. For a discussion of OHV-related sedimentation and erosion, refer to Chapter 8.

Bald Eagles and Recreation

Forest Service bald eagle management policy differentiates between "nesting" and "wintering" (i.e., non-nesting) eagles. Currently, bald eagles nest at Lake Pillsbury, but appear to be wintering further up the Eel River and Rice Fork. Preliminary 1995 surveys indicate two to three pairs of eagles occupying territories around Lake Pillsbury and its arms. (See Chapter 5 for current findings on eagles at Lake Pillsbury.) Four nest areas are known to exist around the lake, with the more recently established sites the furthest south (USDA Forest Service 1995). Jenkins, et. al. (1988) found eagle activities primarily in the southern reaches of the lake, with observations on the western shore only in winter. Winter roost sites have not been comprehensively identified for the area.

Human activities are known to disrupt eagle activity patterns and in some cases cause reproductive failure. Bald eagles will move away from disturbance below them. "Isolation is an important feature of bald eagle wintering habitat....eagles consistently use the bank of the river with the least human activity....Human activity may be the reason that some suitable wintering habitats are not used by eagles." In spite of this, many eagles nest and winter near human population centers. Many types of human disturbances at certain minimum distances and at certain times of the year are compatible with eagles. Nevertheless, regulation of human activity is a critical part of eagle habitat management (USDI Fish and Wildlife Service 1986).

Potential disturbances to bald eagles in the basin include: roads along the west, north, and northwest portions of the reservoir; campgrounds and boat launches; lake-surface use; and the Gravelly Valley Airstrip on the north shore. Due to a vegetation buffer, the inhibition of passing through private areas, and the protective attitude many of the residents hold toward the eagles, the Forest Service summer home site has been viewed by Forest biologists as being compatible with the presence of the eagles (Jenkins 1988).

In the Forest's Biological Assessment for the Proposed Land Management Plan (1995), the Forest wildlife biologist states that "there appears to be a negative correlation between increased recreation facilities [at Lake Pillsbury] and nest success." The Biological Assessment states that "three nests...were used almost continuously from 1967 through 1987. These nests are in line of sight of the north end of the lake. In the years 1986 and 1987 a campground and two boat launches...were constructed [at the lake's north end]....the eagles moved their nest site...in 1988. The...[1988] nest tree was located in an area sheltered from activities at the north end of the lake."

"Construction of 2 additional campsites occurred in the 1993 and 1994 season. Of these two sites, one is located in direct line of sight of the nest...and the second is located along the...shore north of the nest...in 1994 the pair nested...south of the lake...During peak weekends eagle foraging is prevented by the intensity

of recreational use. Recreational development and uses appear to be negatively influencing these birds" (USDA Forest Service 1995).

Of the developed sites around the lake, only summer homes are known to lie within potential core nest areas. Summer homes and Lake Pillsbury Resort are known to lie within potential secondary nest areas; a recreational trail may cross one potential nest area.

Eagle winter roost sites in the Upper Main Eel watershed have not been identified and surveyed; thus, the effects of winter recreational use on the Lake Pillsbury eagles have not been established. Research indicates that wintering eagles are susceptible to human disturbance. Airplanes flying at altitudes of 30 to 90 meters (100-300 feet) above wintering sites rarely disturb wintering eagles, but motorboats, drifting boats, and fishermen can disrupt wintering eagle activity patterns. Automobile traffic seems to be one of the least disturbing human activities in wintering habitat; eagles apparently become conditioned to vehicles on and near roads (USDI Fish and Wildlife Service 1986). Once people leave their vehicles, however, eagles may again be highly reactive to their presence.

According to the Recovery Plan, pedestrians appear to be more of a disturbance than cars but less than boats. A screening of heavy vegetation may reduce the disturbing effect of foot traffic, because eagles flush more readily when in view of hikers who are clearly visible. Minor auditory disturbances without associated visual cues do not appear to disrupt the activity of wintering eagles (USDI Fish and Wildlife Service 1986).

Aviation and the Gravelly Valley Airstrip

Estimates of fixed-wing use at Gravelly Valley Airstrip have been steady, although no precise, current aviation counts exist. There is no landing fee for the airstrip. In 1994, four helicopter medical evacuations took place, although helicopters do not require an airstrip to land (USDA Forest Service 1995). The Forest Service has not recently used the facility, except for annual smoke-jumper training.

The FAA record for the airstrip advises caution due to hang-gliders in summer. Hang-gliding use of the facility and the entire Hull Mountain area is popular during the summer months. Flyovers during a Memorial Day weekend (PG&E 1986) have found twice as many hang-gliders as airplanes at the airstrip, indicating a safety risk, particularly on peak weekends, due to lack of a base operator. The airstrip's north approach is blocked by Hull Mountain. Powered aircraft must therefore both approach and depart over Lake Pillsbury.

Several fatal accidents have occurred during private use of the airstrip in recent years. Crosswinds, southwest tail winds, and sudden wind gusts may be factors in aircraft accidents.

Aviation use may be a threat to, and be threatened by, eagles. Raptors can be hazardous to the safe functioning of approaching and departing aircraft, while the risk of collision poses a threat to the eagles. Due to their greater maneuverability, helicopters pose less risk. Activity at the airstrip could be related to the eagles' move to the south end of the lake. A direct correlation has not, however, been established.

9.6 Future Trends

Recreation and Development

The Mendocino National Forest's Proposed LRMP includes direction for improving access to Lake Pillsbury to provide a safer, high-quality recreational experience. Potential improvements include increased road width and surfacing. As travel time and accessibility are factors in visitation levels, improvement of any route to the lake is expected to increase use (USDA Forest Service 1991a). Paving of the road will be considered in a NEPA document before potential implementation. (See Section 10.6 for additional guidance.)

The Forest Service estimates use levels in "recreational visitor-days" (RVDs); one RVD is equal to 12 hours of individual recreational activity on the forest. 1992 recreational use of the Basin was estimated at approximately 150,000 RVDs lakeside, and 20,000 RVDs lake-surface use (Forest Service facilities only). Navy Camp and Fuller Group Camp are expected to increase usage to a total estimated use of around 175,000 RVDs. North Bay population increases and expansion into Cloverdale and Ukiah are expected to increase visitation pressure on Lake Pillsbury.

Given the 10 percent per year increase in use projected by the District Ranger in 1992 to follow potential paving (USDA Forest Service 1991a), use levels after five years would be approximately a quarter-million RVDs and, assuming continued increases, approaching one half-million RVDs after 10 years. Increased use could be greater once access becomes easier, given the 1.2 to 2 million visitor-days reported annually by Lake Mendocino, currently about a hour's less travel time than Lake Pillsbury.

The Forest landscape architect forecasts filling of existing and new facilities at Lake Pillsbury within three years of road improvement (F. Bell pers. comm.). Crowding could be a resultant perception of some visitors, with additional overflow facilities potentially necessary on peak weekends. However, a certain percentage of outdoor recreationists are attracted to more heavily used areas (Harrington 1987). For this reason, the mix of user groups at Lake Pillsbury could change, with fewer solitude-seeking recreationists returning, and an increasing number of group-seeking recreationists visiting the site. Opportunities for solitude at other regional lakes are infrequent; thus the changeover period could be lengthy. During this period, user-group conflicts could be heightened. Because the fulfillment of expectations is an important factor in visitor satisfaction, any potential change in experience type at Lake Pillsbury from more to less isolated should be accompanied by aggressive information dissemination about potential site congestion (Harrington 1987). (See Chapter 12 for management opportunities related to public information about Lake Pillsbury).

In a different scenario, management of the lake's bald eagle population could restrict future access, use, and development of the basin. Although the outcome of Chapter 7 consultation is impossible to forecast in this watershed analysis, restrictions on further construction, periods of access, and lake-area uses could result in stable or declining visitation to the basin. Power boating could potentially be affected more than non-powered surface uses. Fixed-wing aviation and hang-gliding could also be affected. Lake-surface recreationists could probably be physically accommodated at the other lakes and reservoirs in the region; however, their expectations of a relatively remote, montane lake experience would be more difficult to fulfill. As discussed in the previous paragraph, any restrictions in use types, areas, or seasonal restrictions should be accompanied by clear and consistent public information on the type of recreational experience available at Lake Pillsbury (see Chapter 12).

The greatest sedimentation risk related to any recreational use may be the potential ignition of a large-scale fire. Although neither fire was caused by recreational use, the 1960s Round Burn and the 1987 66,000-acre Mendenhall Burn led to large-scale sedimentation in the past. "A fire in the brush would once again denude the watershed, thus allowing the opportunity for sediment to erode from hillsides and into the streams" (USDI Fish and Wildlife Service 1983). Dispersed uses may carry greater risk than use of developed areas: the potential scale of a backcountry fire is greater than for a fire in more developed areas due to the difficulty of transporting suppression personnel and machinery into a remote area. (Fire and sedimentation risk was discussed in more detail in Section 8.6.)

Off-Highway Vehicle and other Motorized Uses

Research suggests that non-motorized site users tend to feel more crowded by motorists than vice-versa. Due to this imbalance in the perception of crowding, Harrington suggests that "at least for some sites, management of a recreation site as a multiple-use facility is questionable...Equipment use conflicts engender feelings of crowdedness" (Harrington 1987).

Harrington's findings may be applicable to campgrounds within the Lake Pillsbury basin, where both powered and non-powered boaters, hikers, anglers, swimmers, OHV users, and other recreationists may be seeking enjoyment in a setting removed from extensive development. As recreational pressure from most or all of these groups is expected to continue, and likely to increase, over a period in which wildlife and other resource concerns may limit further development, non-motorized recreationists may come to feel increasingly crowded, particularly in the lakeside areas most visited and potentially most restricted. In such a case, it is likely that conflicts between motorized and non-motorized groups would increase. Off-highway vehicle use would likely be involved in increasing user-group friction.

Separation of non-motorized recreational-use sites (e.g., sailing, hiking) from motorized-use areas (e.g., power boating, OHV use) within the Lake Pillsbury basin would be one method of reducing conflict between groups. Use-based zoning might cover both the use area (trail, lake surface) and the campground. As the Forest Service does not manage surface use of the lake, partnerships would be necessary to coordinate zoning management. See Chapter 12 for management opportunities related to this issue.

Erosion and sedimentation caused by recreational activity is expected to remain at current levels.

Bald Eagles and Recreation

Endangered Species and Bald and Golden Eagle Protection Acts Compliance

Management of the bald eagle is directed by both the Endangered Species Act and the Bald and Golden Eagle Protection Act. The former provides for a recovery plan for local and regional bald eagle populations, while the latter prohibits the "taking" (i.e., harming, harrassing, wounding, or killing) of eagles. The Forest's Proposed LRMP states that the Forest "will comply with species recovery plans...as they apply to the Mendocino National Forest."

In the professional judgement of the Forest wildlife biologist, increases in recreational activities or facilities and paving the road or airstrip may affect bald eagles at Lake Pillsbury, and may have the potential to cause them to abandon the area as a breeding site (USDA Forest Service 1995). Compliance with these acts must be reconciled under NEPA planning with the stated intent of the Proposed LRMP to "provide surfaced road access from Van Arsdale to Lake Pillsbury" (see Section 10.6). It may also influence the Forest's decision regarding whether to improve and permit the Gravelly Valley airstrip, or to close it.

Compliance with the Pacific Bald Eagle Recovery Plan

Under the Endangered Species Act, guidelines in the Pacific Bald Eagle Recovery Plan (USDI Fish and Wildlife Service 1986) are in effect in California for management of the bald eagle; as above, the Forest's Proposed LRMP supports compliance. The Bald Eagle Habitat Management Plan is scheduled for update; however, the Recovery Plan supersedes and guides any site-specific habitat management plan.

Tasks to be implemented at the local level to achieve recovery of the Pacific bald eagle are included in the stepdown portion of the Recovery Plan. Those affecting recreation in the Lake Pillsbury Basin include the following:

> 1) "Picnicking, camping, blasting, firearm use...and low level aircraft operations should not be allowed within 400 m of nests and roosts during periods of eagle use. These activities should also be regulated up to 800 m from nests and roosts where eagles have line-of-sight vision. Critical nesting periods vary...but generally fall between 1 January and 31 August. Key wintering areas need protection from disturbance from approximately 15 November to 15 March."

2) "Permanent structures that are occupied during periods of eagle use should not be constructed near nesting or winter use areas. Buildings should be no closer than 400 m from the shorelines of feeding waters. Wooded summer campgrounds... are probably compatible with winter eagle use, but campgrounds in most wintering areas should be closed from November to March."

3) "Boat and automobile traffic can disturb eagles in some areas. Roads should be closed to protect nesting areas, when appropriate...Land use plans should guide human activity away from important feeding perches and prevent human disturbance in nesting and roosting areas...The impacts of auto traffic can be lessened if people remain in their vehicles. In addition, eagles may grow accustomed to the presence of humans at certain locations. Appropriate signs at these viewing points could educate the viewing public about bald eagle ecology and management."

See Section 10.7 for guidance for site analysis and project-level planning and design as it relates to the above guidance for recreation management in the watershed.

An aggressive public information/education program could assist in developing local support for these variable closures and/or restrictions. However, the public least likely to be reached consistently by such a program is the large number of peak-weekend visitors. To maintain public satisfaction with opportunities at the lake, and public support for eagle management, it would be important to reach these visitors before they arrived. See Section 12.1 for discussion of recreational management opportunities related to eagles.

Interpretation

Due to the intensity of public use at Lake Pillsbury, particularly on peak summer weekends, "at some nest sites, roosting areas, and other use areas, bald eagles may be vulnerable to detrimental disturbances by people walking, in land vehicles, and in boats" (USDI Fish and Wildlife Service 1987). The District is currently planning interpretive signs for wildlife at Lake Pillsbury. In addition, assigning interpreters at peak use weekends during the nesting period (Memorial Day and July Fourth weekends) could be a way to alleviate potential conflicts by informing and educating the public about eagles. Interpreters could strengthen local public relations as well as discouraging people from entering especially sensitive areas. See Chapter 12 for further discussion of management opportunities related to eagles.

Aviation and Gravelly Valley Airstrip

Without further development in the Lake Pillsbury area, it is likely that the level of fixed-wing aviation will hold steady. As hang-gliding is a newer use, its trends are more difficult to predict. See Section 13.5 for data gaps in predicting airstrip use. The Proposed Forest LRMP proposes to evaluate the effects of expansion and use of the airstrip on bald eagles, and if found compatible to consider allowing a special-use permittee to run the facility (USDA Forest Service 1995). See Chapter 10 for guidance for site analysis and project-level planning for the airstrip.

10.0 GUIDANCE FOR SITE ANALYSIS AND PROJECT-LEVEL PLANNING AND DESIGN IN THE UPPER MAIN EEL WATERSHED

This chapter focuses on advice for future projects. Chapters 11 and 12 address specific types of management opportunities. These chapters are in concert with the following advice (paraphrased from Kauffman, et al. 1992), which seems to generally apply to good watershed and ecosystem management everywhere:

> Halt or modify practices which deleteriously alter or have the potential to deleteriously alter natural processes.
>
> Return disturbed sites to a more natural state where possible.
>
> Plan future work to be more in concert with natural processes.

10.1 Riparian Reserve Delineation and Project Guidance

The Record of Decision places great importance on riparian reserves. The many values of the riparian zone and concerns about its management were examined in detail in the FEMAT report and in this watershed analysis report. The ROD lists several pages of specific direction regarding riparian reserves. These are a cornerstone of the Aquatic Conservation Strategy and are extremely important in any efforts to improve water quality and fish habitat conditions and to provide for dispersal of late successional species.

The direction in watershed analysis preparation to use known information limits the amount of site specificity that can be attained in designation and refinement of riparian reserves. No field work was undertaken as a part of this analysis to refine riparian reserve designation. As a result, some riparian features such as small ponds and wetlands were probably not included in this first effort.

Sixty percent of the potential matrix lands within the Upper Main Eel watershed were estimated by this analysis to contain riparian reserves. This is close to the 55.5 percent value that the LMP had projected. Riparian reserves were mapped using an Arc-Info geographic information system (GIS) to calculate riparian reserve acreage for ROD default riparian reserve widths. Buffer widths followed the guidance in the ROD. The following features were plotted on GIS to calculate the acreage and obtain a map of the riparian reserves: streams, lakes, ponds, and springs shown on Forest Service Primary Base Series 1:24,000 scale (topographical) maps; inner gorges; landslides; and intermittent streams which were too small to show on topographical maps, but which were inferred from the contour breaks in the topographical maps.

A review of a portion of the watershed showed that some of the headwater riparian reserves delineated by this method projected intermittent streams where none occur, but missed others that are there in reality. This review supports a conclusion that this layer approximates the actual extent of intermittent streams, since the small number of streams missed almost exactly equalled the number of streams projected where none occurred. Ignoring this layer could have led to a significant underestimation of the total riparian reserves. Ground-truthing will be needed both to identify the overestimates and to identify currently unmapped riparian reserves while planning future projects.

Review of the ROD and supporting information in the SEIS and appendices by Mendocino National Forest resource specialists revealed no reasons to widen the reserve widths presented in the ROD for estimating and mitigating the effects of project activities in the Upper Main Eel watershed at this time. The riparian reserve widths delineated in the ROD and implementation of associated standards and guidelines are expected to provide adequate protection of fishery, wildlife, and watershed values in most cases. Some project planners may find site-specific conditions requiring a wider riparian buffer, but such adjustments would be best defined in NEPA analysis.

The team preparing the FSEIS had to allow for conditions throughout the range of the northern spotted owl. Much of this range does not include the dry, Mediterranean climate that is present in this watershed near the southern extreme of the owl's range. Thus, the FSEIS allows for the change of riparian reserve widths and adaptive management on a watershed basis.

Some opportunities may exist to reduce 100-foot riparian reserve buffer widths of first- and second-order intermittent streams in grass, brush, hardwood, and knobcone pine vegetation types, yet meet the ACS objectives and provide adequate protection of riparian values and riparian-dependent species of concern. About 1150 miles of first- and second-order streams within these vegetation types exist in this watershed. In the vegetation types listed above, the ecological needs may be met with a reserve width less than that suggested in the ROD for interim use. Adjustment should be considered, within this 1150 miles, only where site-specific slope, soil and channel conditions allow natural processes and aquatic and terrestrial biological values to be unimpaired with less than the 100-foot buffer width. Project planners should consider and document the conditions and processes of specific areas when proposing reduced riparian reserve widths. As per the ROD, adjustments can only be made following NEPA analysis.

Several items specified in the standard and guidelines included in the ROD should be clarified for the Upper Main Eel watershed:

Direction on pages C-31 and C-32 of the ROD, Timber Management section, allows salvage, if required to attain ACS objectives, after a watershed analysis determines that present and future coarse woody debris needs are met. Existing data are incomplete, but woody debris is insufficient in some parts of the watershed, sufficient in other parts. Also, woody debris levels are higher in some areas than we could expect to obtain under a natural fire regime, but this situation is not necessarily a case of "more is better." Coarse woody debris is a valuable component of watershed health, but high fuel loadings are a risk to watershed health. This tradeoff needs to be considered across the landscape and during the planning of individual projects.

Coarse woody debris needs are not the same in all riparian reserves across the landscape. It was not possible to develop universal standards that could apply to the many different riparian sites across the watershed. Determination of coarse woody debris sufficiency should be made at the project level.

Given the historic fire occurrence in this watershed, fire events will occur within and will affect riparian reserves. Balanced guidance for the desirable level of woody debris might be to maintain the maximum level of debris which limits damage to the riparian reserve during fire events. The intent is to limit fire intensity, so that effects will not be so severe that the reserve no longer serves its functions for watershed protection and maintenance of ecosystem integrity.

Intermittent streams are defined in the ROD as "...any non-permanent flowing drainage feature having a definable channel and evidence of annual scour or deposition." Clearly the team preparing the ROD did not mean for this to apply to road ditches, waterbars or other human-constructed features other than the "constructed ponds, and reservoirs and wetlands" referred to on page C-30 of the ROD. We applied this interpretation, and this interpretation is expected to be applied in subsequent project analyses and design.

The intent behind the riparian standards and guidelines appears to conflict with some specific standards and guidelines. This watershed has dry climatic conditions, localized areas of high fuel loading, and high rates of fire occurrence. These conditions are most acute along permanent system roads due to the higher risk of fire starts and the road system's key role for fire suppression force access. The risk of catastrophic, high-intensity fire and the resultant damage or loss to many resource values is high. The desire to limit fire impacts to the riparian reserves is evidenced in the fire/fuels management standards and guidelines.

The fire/fuels management standards and guidelines section of the ROD (Sections FM-1 and FM-other) will best be met by removing excess fuel throughout the watershed and creating fuel breaks where needed. This strategy conflicts with some interpretations of the timber management standards and guidelines which

prohibit harvest or fuelwood cutting in riparian reserves unless it is needed to attain ACS objectives. However, ACS objectives are furthered by preventing catastrophic fire.

Fuels treatments and fuel breaks should be pursued where necessary, remembering that the prescriptions should vary according to the nature of the riparian areas involved. It appears that lowering fuel loads adjacent to roads would lower the risk of high-intensity fire. Fuelwood cutting of dead and down material within riparian reserves away from perennial streams should be allowed where NEPA analysis supports this activity. Practically speaking, fuelwood gathering would only occur within 100 yards of open roads.

The ROD's prohibition against firewood cutting within the riparian reserves associated with perennial streams should be maintained. This should provide adequate protection of natural processes and fish, wildlife, and watershed values, and assist in achieving the Aquatic Conservation Strategy objectives.

10.2 Specific Land Categories

Late-Successional Reserves

A late-successional reserve (LSR) assessment, which includes a fire management plan, should be prepared for each LSR before habitat manipulation activities are designed and implemented. See the Standards and Guidelines for Designated Areas and Matrix in the ROD for further guidance on conducting activities in this land allocation.

The Upper Main Eel watershed contains approximately 78,564 acres of mapped LSRs, of which about 9,910 acres are plantations. These young forests are generally in large contiguous areas. The desirability of manipulating these stands to expedite the development of old forest characteristics adds impetus to the need for development of LSR assessments. There are also six unmapped 100-acre LSRs in the matrix portion of this watershed, one for each of the six known spotted owl activity centers located in the Upper Main Eel watershed outside of the wilderness and the mapped LSRs (600 acres maximum total). These 100-acre LSRs will contain the best northern spotted owl habitat, and retain it as close to the nest site or activity center as possible.

Until the development of the LSR assessments, most activities will be deferred within LSRs. Some continuing activities will occur as specified in the ROD, including road maintenance and fire suppression as well as fuelwood removal, and salvage under those limited conditions where these activities are consistent with the direction in the ROD. If it is determined that roads or OHV trails within LSRs are limiting reproduction of TE&S species, then those roads or trails could have their use restricted. This would help ensure that LSRs are functioning as they were designed.

Matrix

As defined in the ROD, the matrix consists of those federal lands outside the four categories of designated areas which occur in this watershed (congressionally reserved areas, late-successional reserves, administratively withdrawn areas, and riparian reserves). Timber harvest and other silvicultural activities in the matrix should be conducted according to the standards and guidelines set forth in the ROD. While the matrix lands are identified as those areas where timber harvest takes place, they also serve as dispersal habitat for species between other allocated lands.

Roadless Areas

The ROD states that watershed analysis is required for roadless areas in non-key watersheds prior to determining how proposed land management activities meet ACS objectives. Three inventoried roadless areas (Snow Mountain, Skeleton Glade, and Elk Creek) exist in the watershed outside of the wilderness. The majority of these areas lie within LSRs and riparian reserves. 5687 acres are within matrix. Two of the three areas (Snow Mountain and Elk Creek) were partially burned during wildfires in the last decade, and some roads created by past resource management activities exist in all of these "roadless" areas.

Direction in the Proposed LRMP is to manage the roadless areas in matrix for multiple use objectives. There is no ROD or LMP direction that the roadless areas in matrix in this watershed must remain roadless. However, these areas are interspersed with extensive riparian reserves. Future project planning should avoid increasing erosion and peak flows to deleterious levels.

10.3 Upland Silvicultural Treatments And Prescribed Fire

The Upper Main Eel watershed has the potential for large-scale, high intensity wildfires. There is a need for vegetation and fuel treatments to restrict the size of catastrophic fires. Wildlife habitat, stand development, and biological diversity may also benefit from restoration of the natural fire regime to this area.

Fuel reduction to mitigate wildfire risk is considered necessary to restore the area so that natural processes can function. The reduction of fuels near populated areas, high recreational-use areas, key topographic locations, and in high resource value areas is essential for effective and efficient wildfire suppression. Reduction of catastrophic wildfire potential within fire-adapted plant communities is most important in the dry and intermediate provinces (USDA Forest Service and USDI BLM 1994a). This can be implemented within the Upper Main Eel watershed through project-level planning.

The shift of emphasis in prescribed fire from broadcast burning of clearcuts to under-burning includes some inherent risks. Large areas may burn in mosaics with varying fire intensity and severity. The effects of larger burns need to be evaluated on a landscape scale within the context of the dynamic forest ecosystem. We need to evaluate the aggregate forest ecosystem and the trend of that system, and not be excessively concerned about individual features or if they are sufficiently protected from the effects of a treatment.

At the same time, fuel reduction projects can be phased in temporally and spatially. Project planners will need to consider what project prescriptions best balance the different resource needs. For example, appropriately planned projects would minimize project effects on TES species to maintain their distribution in the watershed now, while enhancing watershed health and habitat for many species, including TES species, in the long run.

"Guaranteeing" that prescribed fire will not enter riparian reserves through the installation of fire control lines may, in fact, be less likely to achieve the objectives of the Aquatic Conservation Strategy than the less destructive approach of using "natural" differences in fuel moistures to restrict the location and intensity of prescribed burns in riparian areas.

Project design should also consider forest moisture regimes in prescribing site-specific standards for downed woody material. For example, it is unlikely that arid sites have historically supported the habitat for moist-site-adapted organisms. Management practices may have encouraged colonization of sites where these species would not have occurred. It is probable that the fire regime in place before fire suppression was undertaken produced lower levels of dead and downed wood than are now considered optimal for some species of interest. Future projects should consider what range of conditions would best meet the needs of the different species, but also provide a stable, healthy ecosystem.

All burning activities should be done during favorable emission dispersion conditions and during conditions where the desired retention of large woody material will occur. The coincidence of these conditions may conflict with spring nesting periods for the northern spotted owl and other species of concern. Evaluation of the effects of these projects must balance the probable negative effects of hot season wildfire. No action, when evaluating prescribed fire projects, does not mean no fires will occur in these areas; it simply changes the predictability of intensity and timing.

10.4 Cumulative Effects Analysis

This watershed has been a focus of attention for many years due to its important wilderness, fishery, watershed, recreation, and timber values. The cumulative watershed effects of past fires, floods and management activities have affected the health of the watershed. As a result, cumulative effects remain a high concern within the watershed and should be a driving force behind watershed restoration efforts.

The current analysis process could be revised to better reflect cumulative effects to living organisms and their habitat. The analysis process may not fully meet the needs of all riparian-dependent species. For example, the subwatershed that includes Corbin Creek doesn't exceed the threshold of concern, yet it is documented to have impaired fishery habitat. The geological conditions and processes and the hydrological processes that, coupled with disturbances, resulted in this impaired state are still in place. Further disturbances could result in slowed recovery from the impaired state or further habitat impairment, even if the thresholds of concern are not exceeded.

Refinement of cumulative effects analysis tools could enhance our ability to predict effects of future projects. Developing such tools will not be easy and was not attempted for this watershed analysis. Refinement might best be approached jointly by all of the national forests in the province. A further consideration is that at present, measurements of thresholds of concern are conducted the same way throughout the forest. Given that watersheds and subwatersheds which hold anadromous salmonids are of increasing importance, it would be worthwhile to consider making the thresholds even more sensitive where anadromous fish are found or could be directly or indirectly affected by projects.

10.5 Considerations for Slides

As described in Section 8.6, stabilization of even one of the large slides in the watershed would likely have a large effect on the volume of coarse-grained sediments deposited in river and stream channels within this watershed. Some methods of slide control, such as using physical structures and drainage controls might result in prompt control, but can be quite expensive to install. Controlling and/or preventing surface drainage from entering ponds, depressions, and cracks that form on a slide, for example, is an excellent way to slow slide movement. Diverting water away from some depressions would be very easy but draining these areas could conflict with other desired uses. Wildlife, including riparian-dependent species of concern, use some of these ponds for part or all of their life cycle. Since it is not practical to drain some of these areas, special consideration should be given to these areas to prevent further slide movement.

Other methods of slide control, such as using vegetation to stabilize slides, can be less expensive, but it would take several years before control would occur. In addition, the best choices for stabilizing some slides might be non-native vegetation, but this would conflict with the policy that favors the use of native vegetation.

The following should be considered in developing a slide stabilization plan: 1) development of a sediment budget; 2) analysis of the largest slides; 3) use of an interdisciplinary team; and 4) NEPA analysis. The first steps of this process could be developed by contracting the work to local engineering or consulting firms, and/or by working cooperatively with other water users and universities. Taking a proactive role and using any reasonable control methods would best meet the intent of the ACS objectives.

10.6 Transportation Planning

Additional standards and guidelines apply to roads in the portion of the watershed within the riparian reserves, to ensure that Aquatic Conservation Strategy (ACS) objectives will be met.

As directed in the ROD, the Mendocino National Forest needs to form partnerships with state and county road managers and OHV user groups to assure that the road system in total does not contribute to deterioration of water quality or riparian conditions (ROD standard and guideline RF-1).

Standards and guidelines on page RF-3 of the ROD provide direction to "determine the influence of each road on ACS objectives through watershed analysis." An inventory of roads in the watershed has been started to evaluate surface drainage, facilities integrity, and future needs to determine: (1) which culverts need repair, replacement, or upgrade; (2) what road template and road surface changes are needed to reduce or eliminate sedimentation and reduce maintenance costs; and (3) which roads could be decommissioned. Completion of this inventory is consistent with this analysis.

We should also inspect the transportation system during and after storm events in accordance with the ROD to monitor erosion. The presence of anadromous fish downstream of Scott dam makes road inspections and subsequent work a high priority in that part of the watershed. The next priority should be identifying and correcting road drainage problems that contribute to or have potential for degrading other riparian habitat.

The Upper Main Eel watershed is a popular area for OHV users, and OHV trails can potentially conflict with ACS objectives. Existing OHV trails in the watershed are not completely mapped; it would be helpful to complete this mapping. Planners may wish to avoid locating new trails and to emphasize maintenance of existing trails in areas of high-hazard soil-slope combinations (see Section 16.5, Table 16.5-1). The roads and OHV trails should be jointly considered in transportation planning to ensure that ACS objectives are met.

Due to the ACS objectives and diminished funding for road maintenance, it is desirable that the transportation system have the fewest roads that still meet needs for forest protection and management and public access. The existing transportation system should be modified as needed to meet ACS objectives and be maintainable within our projected road maintenance budgets. Inability to modify and/or maintain roads in sensitive sites could limit our ability to meet ACS objectives. Roads not needed for forest management and public access, or outside of our financial ability to maintain, should be decommissioned.

Roads and OHV trails should be located away from unstable and potentially unstable areas, and where they have the least impact on streams, riparian resources, and wildlife. Roads and trails should be designed and maintained to minimize erosion, sedimentation, and peak flows. Culverts should be designed to withstand the flows and debris movement projected to occur with a 100-year storm event.

In light of the ROD standards and guidelines, Aquatic Conservation Strategy objectives, and diminished road maintenance funding, it would be desirable that the transportation system have the fewest trails and roads that still meet needs for forest protection and management, and public access. Stabilized, closed roads would no longer require regular maintenance.

Planning related to road closure should consider the following: locations of elevated sedimentation, erosion, and peak flows, including active or dormant slides; number of stream crossings; number and condition of culverts; location related to the streams; potential impacts on wildlife resources; presence of multiple roads providing access to the same areas; and presence of short (less than half-mile) spur roads that may not be necessary.

Projects that increase access to Lake Pillsbury, such as providing a surfaced road from Van Arsdale to Lake Pillsbury, have the potential to conflict with management of bald eagles at the lake. An improved road surface is expected to increase recreational use at the lake. Potential conflicts may include: the effects on bald eagle

reproduction, foraging, and winter use; compliance with the Recovery Plan for the Pacific Bald Eagle , Proposed Forest LRMP, and future updated Forest Habitat Management Plan for the Lake Pillsbury Bald Eagles; and increased recreational use of the Lake. The following are several key points to consider related to the management opportunity of providing a surfaced road. There are several methods that may be employed to provide a surfaced road, and they all might not have the same effect on access to Lake Pillsbury. The bald eagles at the Lake may be conditioned to certain levels of recreational activities, and increases may or may not be detrimental to nesting eagles. Project NEPA will verify compliance with the Proposed Forest LRMP, and ESA Section 7 consultation, as necessary, would assess whether a surfaced road to Lake Pillsbury would affect bald eagles at the lake, and to what extent.

10.7 Recreation-Related Project-Level Planning

Effects of Bald Eagle Management Planning on Recreation

Compliance with the Recovery Plan for the Pacific Bald Eagle and updating the Bald Eagle Habitat Management Plan may alter recreation management in the Lake Pillsbury area. Planning may include several potential effects on recreation at the lake.

Effects Between 1 January and 31 August

Guidance in the Recovery Plan and the stated intent of the Proposed LRMP to "establish primary and secondary management zones around bald eagle nest sites" may affect land-based recreation at Lake Pillsbury. Camping and picnicking within 400 meters of active nests, or visible at 800 meters from these nests, could be affected between 1 January and 31 August. Areas could be subject to closure upon determination of current nesting use and consultation under Section 7 of the Endangered Species Act. Such determinations could probably be made in March of a given year.

Four nest sites have been occupied on Lake Pillsbury. There are currently two to three pairs of nesting eagles at the Lake, and several more potential nest sites exist. Because bald eagles have been known to reoccupy previously used nests, protection and management of these areas may require making annual closures on short notice a possibility. No developed campgrounds or day-use areas fall within known, potentially active areas; a number of permitted summer homes do lie within potential core and extended nest zones. Several trails are also within them; these may require restrictions. Restrictions would depend upon consultation under Section 7.

Between 1 January and 31 August, lake-surface activities such as boating and jet-skiing could be restricted within 400 meters of an active nest site; and within 800 meters when the lake surface is within the eagles' line of vision from the nest. As eagles often nest in tall trees with wide views over adjacent waterbodies, the 800-meter guidance could apply.

Under this guidance, if nesting occurs on the east shore, an area of approximately one-half square mile in the lake's north arm could be limited in use. With nesting on the west shore, the restricted area could be roughly one-third square mile. With nesting at a site south of the lake, potential restrictions could be limited to the Eel River arm. Should eagle nesting occur on upstream areas in the arms of the lake, it may be possible to provide unchanged recreation on a major portion of the lake. Precise delineation of areas would depend upon Section 7 consultation. As management of the lake surface is outside Forest Service jurisdiction, lake-surface planning, management, and enforcement would require partnerships.

Effects between 15 November and 15 March

Guidance in the Recovery Plan excludes use of recreational facilities within 400 meters of the shorelines of feeding waters between 15 November and 15 March. As eagles are known to feed in Lake Pillsbury, such a closure could affect the six campsites and the day-use area currently open during the winter at Pogie Point. Further construction could be excluded within this zone. The need for these and potential restrictions of other facilities would be determined in Section 7 consultation.

Key wintering areas, including roosts, have not been identified for the Lake Pillsbury eagles. Identification of these sites and their surrounding areas in an updated Lake Pillsbury Habitat Management Plan could affect traffic, recreation, and development within the roost area between 15 November and 15 March.

Planning for Gravelly Valley Airstrip

The Forest's Proposed Land and Resource Management Plan directs NEPA consideration of expansion or closure of the Gravelly Valley airstrip. Existing proposals for developing the airstrip include surfacing, constructing hangars, and providing food service, auto and boat rental, and lodging. Potential additional aircraft landings resulting from these improvements could reach 100 per month during the summer of the fourth year (USFS 1991a). Expansion could increase air traffic around the lake as well as public access to the area. Consultation under Section 7 would take place in order to evaluate this proposal.

As aircraft operations would be clearly visible from nest trees, and airstrip configuration requires approach, departures, and potentially circling over the lake for fixed-wing aircraft, bald eagle nesting at any site on the lake could limit fixed-wing approaches and departures from the Gravelly Valley airport between 1 January and 31 August. Hang-gliding approaches could also be limited. Water landing is subject to the same guidance as other lake-surface activities within this period. Although helicopters may be subject to identical spatial guidelines, helicopter use could be less restricted due to greater maneuverability.

11.0 WATERSHED RESTORATION AND ENHANCEMENT OPPORTUNITIES

This report is not intended to provide management direction or prioritize future management activities in the Upper Main Eel watershed. Rather, it is intended to provide a summary of the past and current conditions and processes, and anticipated future trends, and discuss possible management opportunities that could be pursued.

Some of the opportunities identified in this chapter are on private land. Restoration and enhancement could be pursued solely on public lands, but it would be more beneficial if such work could be pursued cooperatively across the landscape.

There are a variety of restoration and enhancement projects that could be undertaken within this watershed. Restoration activities should deal with the the most severe limiting factors and future threats to the health of the watershed. There is no sure way to predict which mix of investments will ultimately provide for the healthiest watershed.

The most important salmonid restoration opportunities in the watershed appear to be outside of National Forest System lands. Viable populations of salmon and steelhead cannot be spawned or reared in the fishery habitat on these lands, due to insufficient quantity of habitat. Opportunities that could result in obtaining viable fish populations are examined in Section 12.1.

Still, some anadromous habitat enhancement or restoration work on National Forest System lands is needed. The projects that would be most beneficial to the existing anadromous fisheries would occur downstream of Scott Dam, as no anadromous fish are now passing Scott Dam. A significant threat to the riparian and fishery resources is the threat of catastrophic road failures during storm events. Projects to deal with minimizing this risk are examined in Section 11.2.

There are other factors within our control which are currently affecting sedimentation and limiting riparian and fishery values. These factors include chronic erosion problems, elevated peak flows and decreased summer flows, high water temperatures, limited riparian vegetation, limited large woody debris (LWD), and modifications of upland vegetative community structure. Projects that deal with these factors are examined in both Sections 11.1 and 11.2.

A significant problem that affects much of this watershed is the change in the vegetation composition and fuel loading that has occurred because of attempted fire exclusion. The risk of catastrophic fires is high due to this condition. A catastrophic fire would result in a loss of old-forest habitat and the wildlife species that depend upon it, a significant increase in erosion and sedimentation rates, and decreased fisheries productivity. Based on the fire history of this watershed, it is highly likely that wild fires will occur. These wildfires will continue to be highly destructive to resource values until treatments are undertaken to restore the natural fire regime. Projects to protect the watershed as a whole and/or enhance old-forest habitat characteristics are examined in Section 11.2.

Economic opportunities are provided by all of these projects. Recreational opportunities are examined in Section 12.1.

11.1 Projects to Directly Benefit Riparian and Aquatic Values

Anadromous Stocks at Risk

Projects below Scott Dam that minimize elevated sedimentation and erosion and improve riparian health would be immediately and directly beneficial to the anadromous fish. This is especially true in those tributaries such as Bucknell and Soda Creeks. Work that could benefit this habitat includes modifying roads on the

Forest and on private land to reduce erosion that results in sediment deposition in the fisheries. Bucknell Creek is an example of a subwatershed that could use road work such as further described in Section 11.2.

Both road work and riparian planting would also benefit the Main Eel River downstream of Scott Dam. Reducing erosion and increasing shade and cover for fish and future recruitment of LWD would be beneficial to the fisheries. The majority of this work would be on private land.

Silviculture projects in the riparian zones of different streams, such as lower Soda Creek, could increase the integrity of the stream, seasonal shade and cover for fish, and the future recruitment of LWD into this stream and the river.

Slides have blocked fish access to portions of Soda Creek and Bucknell Creek in the past, preventing spawning fish from ascending the streams. Continued monitoring of fish access and channel work is needed to ensure access to current spawning and rearing habitat.

About the first half-mile of lower Soda Creek is a wide, braided channel and it is believed that this condition is limiting fish passage at lower flows. This area might be modified though project work to create a more defined channel but such work might be negated by flooding (see the discussion in Section 3.5). Another complication is that this reach includes a combination of private and public land. Developing a long-term solution would be a challenge. Channel reconstruction in lower Soda Creek might be more successful in the long term if it were combined with upstream bedload reduction projects, riparian silviculture, and road relocation to help provide long-term stabilization.

Another possible solution for the problem in lower Soda Creek would be to use heavy equipment to carefully unplug the channel on an as-needed basis. This gravel is needed for future spawning in the river, so it would be best if it could be placed in the high-flow channel where the river could sort it at high flow.

Salmonids in this portion of the river would benefit from projects to provide additional rearing habitat that minimizes *P. grandis* predation. This could include creating or improving shallow water habitats, especially cobble/boulder riffles. This kind of work would be technically challenging and might not yield a high abundance of fish. Shallow secondary channels might be valuable if they were stable enough to survive high flow events. This work should be approached remembering that if *P. grandis* could be eliminated in the Upper Main Eel watershed, salmonid habitat preference would change. Also, it would not be wise to try to modify the channel in excess of the range one could expect within natural processes and the modified flow regime. This type of project should not be pursued without additional consideration.

Other types of projects were considered, but do not seem to be cost-effective, since they do not address the key factors limiting the fisheries at this time. Pool depth and abundance and LWD abundance are below optimum in most of the Upper Main Eel tributaries, but adding LWD and boulders to create additional habitat would not likely result in a significant increase of juvenile or adult salmonids over the long-run; low summer flows and high summer temperatures are the bottleneck on fish production in this habitat. Likewise, log and boulder placement in the deep pools of the Upper Main Eel River does not seem worth pursuing at this time, considering that *P. grandis* would probably benefit more from such work than would salmonids.

Several barriers exist on tributary streams, such as Benmore and Welch, but the fishery surveys suggest that it would not be cost effective to mitigate these barriers, due to the fact that a significant amount of work would be required to access limited habitat.

Riparian Silviculture

Portions of the Upper Main Eel River and many of its tributaries on the Mendocino National Forest including Rice Fork and Soda, Rock, Salt, and French Creeks have channels that were altered by natural and human

disturbance. They have limited riparian vegetation and have immediate need for restoration. Such work would ease erosion and sediment problems, and greatly benefit riparian and fisheries values.

Native riparian vegetation planted along the streams in areas with limited vegetation would provide many benefits. It would provide stream shade to help reduce high water temperatures and evaporation. Planting vegetation would enhance riparian health. This would increase the riparian zone's ability to store and slowly release water. Other benefits include increased stream stability, large woody debris recruitment, and fish-hiding cover.

All of these benefits would result in increased habitat for terrestrial and aquatic species. This type of work has little risk other than the tradeoff of cost since restoration dollars are limited. A consideration is that it will take over one decade to obtain the larger benefits of treatment; obtaining large conifers to provide large woody debris recruitment would take considerably longer.

Species should be chosen depending upon site potential and availability of appropriate plants. Planting a mix of native species will help maintain vegetative diversity in the riparian zone. Planting conifers, including grey pine, cedar, and Jeffrey pine, cottonwoods, and oaks along the high bars, and more conifers and browse species on eroding slides, would benefit wildlife as well. These plants would provide both food and cover for numerous species and enhance connectivity for certain species.

Existing vegetation could be manipulated to enhance the growth and health of individual trees that have the potential for extended height growth (Douglas-fir, ponderosa pine, and others). These trees could provide long-term shading and large woody debris. Specific riparian silvicultural techniques will need to be planned on a site-specific basis through the NEPA process.

Riparian Grazing Management

Livestock grazing occurs on both public and private land in this watershed. Expanding cooperative efforts to improve riparian conditions and habitat for riparian-dependent species of concern across the entire landscape would be beneficial.

Management for Riparian-Dependent Species

Special riparian management projects may be identified following future surveys, especially related to riparian species of concern. Habitat enhancement projects which would benefit species such as red-legged frog, western pond turtle, or willow flycatcher (especially to enhance recruitment) are consistent with this report (see Chapter 4).

Some riparian fencing may be required to provide improved habitat in key areas. Creation of improved breeding or rearing habitat might help mitigate loss of habitat. Management of frog and turtle habitat would probably be most effective in and around the small ponds of this watershed; trying to create juvenile habitat along the margins of Lake Pillsbury would also be effective. For example, construction of shallow ponds near western pond turtle breeding sites would provide habitat for juvenile turtles and red-legged frogs.

To successfully create habitat that would benefit these species, the following items need to be considered: presence of exotic species; effect of project design on the potential for intrusion by exotic species; possible side effects of the project on species of concern and other species; site potential for riparian vegetation; water storage capability; types of recreational use; and other human disturbances.

11.2 Projects to Directly Benefit Terrestrial Values

Opportunities to Benefit Early Successional Wildlife Species

Early successional wildlife species will benefit from maintaining and establishing early seral habitat in mosaics across the landscape of this watershed. This can be accomplished by moving toward a natural fire regime. The current conditions in this watershed were established by large infrequent fires. These fires have created large, even-aged areas of vegetation that are decreasing in nutritional value and wildlife use. By moving toward restoring the natural fire regime, a mosaic of vegetation seral stages will be created and vegetation diversity maintained. The regeneration of vegetation in response to fire will create additional browse and forb growth which is more palatable and nutritional than older vegetation, and can be utilized by bears, deer, elk, and other wildlife species. Maintaining seral stage diversity will assure that the diversity of wildlife species is maintained. See Section 12.1 for potential partnership opportunities.

Opportunities in Late-Successional Reserves

There are management opportunities that exist in mapped late-successional reserves and unmapped late-successional reserves including release, thinning, and fuels reduction. These treatments and their proposals should be considered when developing LSR assessments. Guidelines for what should be included in those assessments are found on Page C-11 of the ROD. The following are examples of some of the opportunities that exist in this watershed; further management activities may become apparent when additional data are gathered:

Reduction of fuel loading by treating slash created by past timber sales and precommercial thinning.

Thinning, release, and understory burning in younger stands to reduce the possibility of a stand-destroying event which would decrease future potential habitat, and to accelerate the creation of late-successional forest conditions.

Thinning and understory burning in established stands to accelerate the creation of late-successional forest conditions and reduce the risk of losing the stand. This will provide greater assurance of long-term maintenance of habitat.

Thinning and fuel treatment around unmapped late-successional reserves to reduce the risk of natural disturbances that would not allow the area to fulfill its desired role.

Thinning and understory burning to complement natural fuel breaks to reduce the possibility of stand-destroying events occurring on a large scale.

Construction and maintenance of a system of modified fuel profile zones to limit the scale of disturbance events. This could limit the risk of destroying habitat function for entire LSRs.

Thinning and planting to develop multi-layered stands, which would promote formation of late successional characteristics.

Silvicultural treatments inside reserves are subject to review by the Regional Ecosystem Office to ensure that the treatments are beneficial to the creation of late-successional conditions.

Upland Silvicultural Treatments And Prescribed Fire

Reducing the risk of catastrophic fire helps protect wildlife and fishery resources, and reduces the risk of erosion following a catastrophic fire. Approximately 181,000 acres of vegetation exist in various fire-supported ecosystems within the Upper Main Eel watershed. Red fir vegetation types are not included due to the small impact fire has had in shaping these ecosystems. Given the historic fire return intervals displayed in Section 6.6, treatment of approximately 7,000 acres per year within this watershed would assist in moving the vegetation toward a more stable condition.

Fuel reduction projects can reduce future fire intensities, resulting in vegetation that is less prone to large-scale disturbance events and better able to meet resource needs. Possible projects include direct treatments such as prescribed fire and indirect treatments such as thinning and disposal, fuelwood removal, harvesting of wood products with slash disposal, and others. In general, projects that create 4-foot flame lengths in older stands and 2-foot flame lengths in younger stands will meet this standard. Projects that result in this level of fuel modification will be able to protect large deep-rooted trees and shrubs that provide cohesive strength against slides. This level of forest vegetation density will keep evapotranspiration at a level that supports soil stability while minimizing the chance of high-intensity fires that would deforest large areas.

While prescribed fire may mimic natural under-burning, there are risks associated with retaining coarse woody debris and preserving remaining trees and snags. Retaining these features in the wrong place increases the potential for re-burning. Spotting potential and the possibility for a prescribed burn escape would be increased as well. This could result in additional resource damage and unanticipated smoke emissions. Also, burning costs will increase due to the need for rapidly extinguishing smoldering fuels and the existence of "unnaturally" high fuel loads resulting from several decades of fire suppression.

Future burning for hazard reduction and site preparation will frequently be required in stands with many more trees retained than was previously common. This is in part due to the green tree retention standards in the ROD. This will lead to changes in prescribed fire techniques. It is anticipated that by conducting prescribed burning under advantageous weather conditions, subsequent wildfires and wildfire smoke emissions may be reduced due to a decreased amount of available fuel and a lowered risk of large-scale wildfires.

Creation of fuel treatment zones on key ridges and in places that connect natural barriers will preserve opportunities for maintaining key components of existing vegetation by reducing the scale of catastrophic loss. Fuel treatment on a scale large enough to effect a reduction of resource damage on the watershed as a whole cannot be accomplished for several decades. Meanwhile, treating key areas would compartmentalize the watershed so that the extent of catastrophic losses would be minimized. These key ridges are identified on plans prepared at the ranger district level.

Treatment may result in less than optimum levels of downed woody material and snag numbers within treated areas. This trade-off may be worthwhile to achieve the objectives of the Aquatic Conservation Strategy and aid in the retention of large blocks of late successional forests over time. Project design of these areas should attempt to protect and manage reserve areas and meet the standards and guidelines in the ROD.

Many existing plantations of young forests are scattered throughout the watershed. Manipulation of the vegetation and fuel mosaic in and adjacent to these areas can contribute to achieving forest objectives.

While decisions regarding specific areas where work will occur will be made through the NEPA process, it might be beneficial to pursue work in certain drainages and compare it with untreated control drainages. Monitoring studies could aid in determining the efficacy of the treatments (see Chapter 14). This is in essence practicing the adaptive management approach encouraged by the ROD.

Rehabilitation of Barren Areas

The barren areas comprise less than 1 percent of the watershed, but they still pose a problem for watershed health. Rehabilitation of the barrens would help meet Aquatic Conservation Strategy objectives by restoring watershed integrity and providing sediment and water flow control which would enhance downslope riparian areas and fisheries.

The barren areas could be replanted with native vegetation and protected from disturbance until better ground cover is established. Revegetation efforts would likely require that seeds or cuttings be collected and the plants be started in a nursery. The top layer of soil has been lost in the barren areas, so special site preparation would be needed. The addition of mulch, soil amendments, or woody debris to some of these areas might create microsites that would speed revegetation. Adjacent harvest or fuel break projects could provide material for such work. It would be important to avoid adding materials likely to lower the soil pH, as the soil pH is already too acidic in the barrens.

Modification or Closure of Existing Trails and Roads

The Bucknell Creek subwatershed has been identified as one where the OHV trail and road system needs modification. Non-anadromous areas in need of work include Corbin Creek, Anderson Creek, and Rice Fork.

The potential for road failure at stream crossings poses a large risk to the health of the riparian zone and the fisheries, and to the attainment of Aquatic Conservation Strategy objectives. Numerous culverts should be replaced; the culverts are old, and some are rusting out and could fail in the next above-normal storm event. Culverts at stream crossings could have end sections installed, where needed, so that woody and rock debris would pass freely, lessening the chances of culverts being plugged during storms. Debris racks and risers could be installed where warranted.

The addition of rolling dips at some stream crossings could lessen the impacts of failure of plugged culverts. Energy dissipators could be installed on culvert outlets to reduce stream scour and bank cutting. In-sloped roads could be out-sloped where possible and water-barred as needed, so water drains off the road onto vegetation below the road prism.

Highly traveled roads in the watershed that are subject to surface erosion need a stable road surface to eliminate rutting and dusting. Road surfaces could be stabilized with rock, or chip-sealed, where needed. Road closure devices should be repaired or modified where needed to halt unauthorized use of roads and prevent erosion and the need for additional maintenance work. Road cut and fill slopes could be stabilized with vegetation to prevent sloughing and rilling.

Roads not needed for forest management and public access could be decommissioned to reduce surface erosion, and to eliminate the need for maintenance and potential for large fill failure. Decommissioned roads could be vegetated with grass, brush or trees. This work would restore natural runoff and eliminate road-related erosion.

12.0 ADDITIONAL MANAGEMENT OPPORTUNITIES

12.1 Partnerships and Cooperative Agreements

Aquatic and Riparian Resources

Coordinated Planning Considerations

Partnerships appear to be one key to successful management of the Upper Main Eel watershed fisheries. Many different agencies and special interest groups are interested in the beneficial uses of water, including restoring the Upper Main Eel watershed fisheries. Some of the restoration work identified in Chapter 11 should be pursued on state, federal, and private lands. It would be beneficial to develop some sort of coordinated resource management plan that could function cooperatively across administrative boundaries. It should be possible to develop a plan that would meet the needs of both fish and people. A river basin analysis would help focus what efforts are most needed in this watershed in context with the whole basin.

Some individuals and groups have suggested that significant changes need to take place to save the dwindling runs. Most agree that *P. grandis* must be controlled. Other ideas include the elimination of Scott Dam, building passage structures to get salmonids upstream of Scott Dam; and increasing the amount of habitat available to salmonids by trucking adults above Lake Pillsbury to spawn.

It should be remembered that if *P. grandis* were still too numerous, this work might have little value. Also, juvenile fish rearing above Scott Dam would have problems getting downstream past that dam; downstream fish passage has not been effectively studied. Additionally, the socio-economic reality is that hundreds of thousands of people are dependent upon the Potter Valley Project.

Given all of the problems for maintaining a chinook run in the Upper Main Eel watershed, some biologists have suggested that chinook could never maintain themselves here. These biologists advocate not placing chinook above Cape Horn, forcing them to spawn somewhere downstream as other chinook and coho do now. This subject would best be examined at the basin scale with all affected interests.

Existing concerns about the profitability of the Potter Valley project, dam safety, water storage capacity, salmonid declines, and obtaining flows to meet the needs of both fish and people make it likely that the project will be reevaluated in the future. Modification of the existing project would require (under FERC license) negotiations by the affected parties; it is possible that the project would be decommissioned and the dams removed, or alternatively that an even larger impoundment would be created. Possible compromise plans are numerous, and it is outside the scope of this analysis to develop a plan that should be negotiated among the different interested parties.

Another possible partial solution to the declining salmonid runs could be careful, continued expansion of the state's bioenhancement hatchery program. This work would benefit from creating new partnerships among the agencies and publics. There are diverse opinions from the public and fishery professionals about this type of work. Everyone can agree that salmonid returns have dropped and that immediate actions are needed. The state's decision to conserve the remaining gene pool through some form of hatchery augmentation is accepted as valid by most people. Continued discussion and consensus building on the hatchery program should lead to a plan that obtains public buy-in and good results. Again, specifics about such plans are outside the scope of this analysis.

Ptychocheilus grandis (Sacramento squawfish)

A partnership opportunity exists within the Eel River basin to address the issue of *P. grandis* population control. No single agency can adequately address the issue and provide relief from this basin-wide problem.

Viable populations of salmonids require more habitat than is available now on Forest Service lands in this watershed. Upper Main Eel watershed salmonids also spend a significant portion of their life cycle downstream of the watershed. The decline of salmonids in the Upper Main Eel watershed can be attributed to many factors, but it appears that *P. grandis* played a key role in the steelhead decline. *P. grandis* predation upon, and competition with, juvenile salmonids needs to be reduced or eliminated where possible.

It appears that a combination of solutions will be needed to deal with the *P. grandis* problem in the Eel River basin. Chemical treatments, like the proposed rotenone work, might eliminate *P. grandis* from the watershed. Even so, *P. grandis* would still pose a threat to juvenile salmonids downstream of the Cape Horn Dam. Further work should be conducted to determine how to selectively control *P. grandis* abundance.

The recent work establishing *P. grandis* fishing derbies has been helpful, but the scale has not yet been large enough to have a significant effect on *P. grandis* numbers. Significantly increasing public interest in catching *P. grandis* would benefit salmonids and provide additional recreational and economic benefits. This would be especially true in the warmer stretches of the river during the hot months. Salmonids shouldn't be there then, so there should be no increased fishing pressure on the salmonids. The state could also consider additional changes to the fishing regulations to favor salmonids and disfavor *P. grandis*.

Reducing *P. grandis* numbers should result in increases of salmonids and other aquatic species. Any reasonable methods that will obtain these ends should be pursued. The California Department of Fish and Game is the lead agency on this problem, but to be successful they will need the cooperation of other agencies such as Forest Service Research and the U.S. Fish and Wildlife Service, university researchers, and interested members of the public.

Other Introduced Fish

Introduced gamefish are believed to be impacting native western pond turtles and northern red-legged frogs in this watershed. An opportunity exists within the watershed to develop partnerships to manage certain bodies of water for native species, rather than introduced gamefish. One approach might be to manage to favor native species in the the small ponds and lakes, but continue to manage to maintain or enhance the recreational fishery in Lake Pillsbury. Special management at the small ponds and lakes would provide turtles and frogs with better habitat and help anchor viable populations in the watershed. This would include removing non-native fish and prohibiting introduction of fish into those waters.

If a rotenone treatment were conducted to remove *P. grandis*, it would be advantageous for native frogs and turtles if Lake Pillsbury were not restocked with non-native sunfish species (such as green sunfish and smallmouth bass) likely to disperse up tributary streams and predate upon native species. Other species of sunfish which are less prone to predate upon upstream native species would be a better choice if warmwater fishing opportunities are desired.

Vegetation

There are additional opportunities for the Forest Service to form partnerships that relate to other aspects of management of the Upper Main Eel watershed. The Forest Service could foster the development of additional coordinated resource planning areas to promote coordinated planning and implementation of vegetation management activities between owners within the watershed. This would allow the various owners (government and non-government) to participate cost effectively in burning and vegetation management practices.

Habitat Management for Early Seral Species

An opportunity exists in this watershed to manage vegetation and create mosaics of seral stages that would be beneficial to early successional wildlife species. These wildlife species include, but are not limited to, deer, bear, quail,and some neotropical migrants. There are many opportunities available to develop partnerships that would be advantageous for the Forest to pursue for habitat manipulation, or projects. Some of these are with the California Department of Fish and Game, Audubon Society, Mule Deer Foundation, Izaak Walton League, and the Rocky Mountain Elk Foundation.

Recreation

As with several other resource areas, partnerships appear to be the key to successful management of recreation in this watershed, particularly in the Lake Pillsbury basin. Several agencies and interest groups are interested in management and opportunities at Lake Pillsbury. Several of the opportunities listed below and in Section 10.7 require coordination and cooperation between parties to function effectively. With adequate interagency and public cooperation, it should be possible to develop strategies which respond to the public's varying needs.

Public Relations and Interpretation Related to Bald Eagles

The Pacific Bald Eagle Recovery Plan emphasizes public awareness and education as important tools for managing interactions between humans and eagles. The plan recommends developing public information programs to foster awareness of and commitment to solving the problems facing eagles. An appreciation of eagles and their habitat is important.

General information programs can include brochures, posters, slide programs, press release kits, and news releases. Any public affairs materials developed should be distributed to all partners or interested organizations in the area, including local tourist bureaus. Public information programs geared to basin residents can help elicit support of Forest management efforts.

Eagle viewing and interpretive areas can provide unique experiences for the local and visiting public. The District is currently planning wildlife interpretation signs for installation at Lake Pillsbury in 1995-96. Continued management could include an interpretive brochure or volunteer interpreter program. Access to viewing areas should be controlled and risk of disturbance to the eagles should be minimized. Partnerships could be developed in which volunteers could be called upon to assist in handing out literature and acting as eagle "interpreters" on peak weekends.

Potential use or area restrictions resulting from consultation under Section 7 of the Endangered Species Act and compliance with the Recovery Plan for the Pacific Bald Eagle would require an ongoing program to notify visitors of recreation restrictions before they chose to come to the lake. Whiskeytown Reservoir, for example, announces eagle-nesting-related closures in early February via public radio and local newspapers. In addition to broad-scale notification, clear signs at Forest boundaries and along the main access roads to the lake would notify visitors before they traversed the entire route.

Recreation Management

Use Zoning

As discussed in Section 9.6, alleviating feelings of crowding and potential conflicts between motorized and non-motorized recreationists could be a valuable method for accommodating existing and changing recre-

ational patterns in the Lake Pillsbury basin. In updating the Forest's OHV plan and in other site-specific NEPA work in the watershed (see Section 10.7), planners may wish to consider zoning both recreational use areas and campgrounds for either motorized (e.g., fixed-wing, power boating, OHV) or non-motorized (e.g., hang-gliding, sailing, hiking) use. In cases such as lake-surface use, partnerships or cooperative agreements would be necessary to create consistent zoning and enforcement in use and camping areas. Defining and publicizing the types of opportunities available at any given site would increase the probability of visitors choosing an appropriate site and thus having their expectations met (Harrington 1987).

Lake Pillsbury Image Clarification

The results of this analysis indicate that contradictory or unclear published information regarding recreational opportunities at Lake Pillsbury may contribute to the potential for conflicting public expectations of opportunities at the lake. For example, while Lake County promotional materials indicate fishing as an opportunity at the lake, no mention is made of the lake's lack of a boating speed limit (outside of landing areas, which have a five mile-per-hour speed limit). Freedom to speed-boat attracts power boaters, jet skiers, and water skiers who may encounter speed restrictions at other regional lakes. (See Section 9.5 for discussion of Lake Pillsbury in the context of other regional lakes.) Power boating may then impact the angling experience. Thus although angling is certainly available at the lake, clarified or more complete information would inform anglers and all lake-surface users of other uses which might affect them.

As another example, a motorcycle industry OHV map indicates the name "Lake Pillsbury" as an OHV destination, without clarifying that the lake basin itself is closed to OHV for half the year. In this case, OHV riders may be drawn to a location where they are then not permitted to ride.

Updating of the Forest's OHV plan as scheduled should help in clarifying and initially publicizing the Forest's OHV management policies. Additionally, the Proposed Land and Resource Management Plan for the Forest contains direction to "analyze and coordinate the development, management, and use of the Lake Pillsbury Basin." This effort should strive to present a clear array of recreational opportunities emphasized or de-emphasized in given areas: group-oriented versus solitude-seeking; motorized versus non-motorized; restricted versus non-restricted; and shared among user groups versus limited to a specific user group. Planning for the basin should examine whether opportunities should be accommodated within the basin, or whether some uses might better be accommodated at adjacent or nearby areas providing opportunities of equal or better quality. Potential zoning could be addressed in this planning effort. This effort should assist in clarifying and providing initial public involvement and information on the Forest's management policy for the lake basin.

Once planning is completed, informing the public should go further than the NEPA process. A number of opportunities exist to form cooperative agreements with local tourist bureaus and groups that may publish recreational information about the area. As selection of one's destination is a core need in recreation and its management, the Forest and its partners should make every effort to work toward providing and correcting information so that visitors may choose their destination with accurate knowledge of its opportunities. In some cases developing or enforcing management policy, or ensuring accuracy of published information, may not be within the jurisdiction of the Forest Service. However, all work toward clarifying the recreational opportunities at the lake will contribute toward a more satisfied public.

Monitoring

There is an opportunity to establish technical and administrative links to other agencies and groups interested in our monitoring. Monitoring partnerships would develop better working relationships with our external partners and help us stretch our monitoring budgets.

12.2 Local Economic Development

Timber Harvest

Harvesting forest products from the Upper Main Eel watershed has provided economic benefits to the region for several decades. Harvesting in this watershed provides direct employment in the woods and in sawmills. One of the social commitments of the Forest Service is to provide commodity outputs, which support stability in the local communities.

An opportunity exists to produce sustainable harvest outputs within the Upper Main Eel watershed. To capitalize on this opportunity, the Forest needs to develop plans to implement harvest activities within the range of sustainable harvest. In addition to regeneration opportunities, these plans should focus on harvests that improve opportunities for future recruitment of late seral stage forests (such as commercial thinning), and on opportunities that assure the presence of hardwoods and shade-intolerant conifers in mixed stands. Many opportunities exist to provide both forest products and add to protection of the forest from catastrophic disturbances. Project planners should consider opportunities to harvest Christmas trees, fuelwood, and non-traditional products where these activities can assist in achieving employment and a healthy forest.

Implementing the green tree retention standards within the matrix should help assure retention of low mobility species, such as those in Table C-3 of the ROD, on sites distributed throughout the forested ecosystems of the Upper Main Eel watershed. This standard and the accompanying downed woody material standards are important for retention of ecosystem functions. Project design should consider forest moisture regimes in prescribing site-specific standards for downed woody material. For example, it is unlikely that arid sites have historically supported the habitat for moist site adapted organisms. Management practices may have encouraged colonization of sites where these organisms would not have occurred.

There is a potential opportunity to salvage-log hazard trees inside riparian reserves and other withdrawn areas, to protect public life and property, reduce costs of road maintenance, and contribute to meeting ACS and other objectives. Such projects should be reviewed for consistency with ROD standards and guidelines. If necessary to meet habitat needs, additional snags and recruitment trees could be left outside areas of high public use.

Grazing

If the desired conditions related to plant community changes (Section 6.2) are achieved, an increase in vegetation suitable for grazing could result. Whether any of this additional forage is available and usable for production of domestic livestock is dependant upon achieving and maintaining desired vegetation cover conditions and riparian protection standards.

13.0 DATA GAPS

The following data gaps can be filled and it would be worthwhile to do so. The data would be helpful, but not having it does not preclude making management decisions. We can still make predictions for how to best manage the watershed and the fishery/riparian values. More knowledge about important species, conditions, and processes within this watershed would improve our future ability to prescribe and prioritize resource protection or enhancement opportunities.

13.1 Anadromous Stocks at Risk and Riparian Ecosystem Function

High Priority Needs

Watershed sediment budget. How much comes from where, where is the worst erosion, and what can we do about it? (This is probably the most important data gap related to prioritizing fisheries-, riparian-, sediment-, and erosion-related restoration projects.)

Stream-crossing and inboard-ditch culvert failure risk assessment. This would include an evaluation of the potential for, and the effects of, a culvert blowing out or a stream being diverted out of its natural course.

Locations, relative abundance, and habitat conditions of existing populations of other TES, or rare, aquatic or riparian-dependent species, i.e., western pond turtle, northern red-legged frog, foothill yellow-legged frog, willow flycatcher, and bats.

Level of grazing use that will meet ACS objectives.

Long-term trend of water temperatures on key fishery tributaries such as Soda and Bucknell Creeks.

Long-term trend of water flows on key tributaries to the Upper Main Eel River.

Accurate locations of fish barriers, active landslides, and other significant features. This might best be done with the use of the fairly affordable, small, GPS units now available.

Assessment of which culverts and road crossings limit juvenile upstream fish passage to important rearing habitat.

Existing non-game fish community structure, species abundance, and diversity in representative stream reaches, especially upstream of Lake Pillsbury.

Existing macroinvertebrate community structure, species abundance, and diversity in representative locations.

Need for Historical Data

[The following are data gaps that we can never completely fill. It is possible that subsequent archive review could locate some of this information. Information to fill the first data gap listed would be particularly important, as it would provide significant insights into past riparian and fishery habitat and would help us better gauge future management proposals. See Section 14.1 for inventory/monitoring that might fill this gap.]

Historic riparian physical and vegetative conditions.

Historic level of large woody debris (LWD).

Historic abundance of adult and juvenile salmonids.

Historic aquatic macroinvertebrate community.

Cooperative Needs

[This work would have to be pursued by our partners, such as the California Department of Fish and Game, as the Mendocino National Forest is not responsible for performing such work.]

Locations and/or effective techniques of controlling *P. grandis*.

Estimates of fish harvest (recreational and commercial) on salmonids native to the Upper Main Eel watershed.

Estimate of daily streamflows into Lake Pillsbury.

13.2 Threatened, Endangered, and Special Status Species

[Throughout this analysis it has been apparent that many data gaps exist with regard to wildlife in this watershed. This condition is not unique to this area, however. In fact, lack of accurate information with which to monitor wildlife populations is a common factor throughout the Mendocino National Forest.

Data needs include species population information and information on the presence and distribution of habitat components important to wildlife needs. Evaluation of suitable habitat for the northern spotted owl, northern goshawk, and furbearer species for the Mendocino National Forest is critical to maintaining habitat throughout the watershed and the Forest. The definition of suitable habitat for the northern spotted owl described by Thomas et al. (1990) is not specific to the conditions found in this area of their range.

The following are lists of elements for which data need to be collected. Elements are listed in order of priority within categories.]

Northern Spotted Owl

Forest specific definition of dispersal habitat and distribution within and between watersheds.

Forest specific definition of suitable habitat and distribution within and between watersheds.

Reproductive status for all pairs in mapped LSRs.

Population numbers in mapped LSRs.

Function of LSRs over time (ability to support estimated owl populations).

Utilization of habitat components.

Effects of OHV trails and road use on nesting spotted owls.

Occupancy of un-mapped LSRs.

Presence in un-surveyed habitat.

Population numbers in the matrix.

Demographic studies.

Bald Eagle

A current habitat management plan for bald eagles at Lake Pillsbury.

Recreation and eagle interactions.

Winter roost sites.

Identification of other potential or capable habitat.

Utilization of habitat components.

Factors affecting reproduction.

Demographic studies.

Peregrine Falcon

Use of potential, enhanced, and existing eyries.

Northern Goshawk

Locations of new territories and use of known territories.

Current population numbers.

Demographic studies.

Furbearers

Current population numbers.

Demographic information.

Snags and Downed Wood

Utilization of snags and downed woody material as habitat components by wildlife species.

Number of snags per acre, their condition and species.

Number of downed logs per acre, their size and condition.

The balance of downed woody material that will meet the needs of wildlife and fuels.

Decomposition rate for snags and downed logs.

Cavity-Nesting Species

Number of recruitment trees and snags required to maintain 40 percent of cavity-nesting species.

Species composition, distribution, and habitat utilization of cavity-nesting species.

Population densities and distribution of white-headed woodpecker, pygmy nuthatch and flammulated owl.

Table C-3 Species, Attachment C (Appendix J-2 species)

Population occurrences, and distribution of these species.

Management Indicator Species

Population, occurrence, and distribution of these species.

Potential habitat maps by species.

Neotropical Migrant Bird Species

Population, occurrence, distribution, and habitat utilization of these species.

A potential species list.

Potential habitat maps by species.

Plants

Trends in the vigor, distribution, or habitat of TE&S plants.

13.3 Plant Community Changes

In-place studies of plant successional trends for both terrestrial and riparian vegetation types.

Inventories of fuel loading and size classes.

Data on habitat needs for species listed in table C-3.

Pre-contact vegetation patterns.

Potential natural vegetation.

Spacial, temporal and intensity information regarding past harvest activities.

A description of lower layers of vegetation within forests of the watershed and a description of how they occur over the landscape.

Long-term air quality trends in the watershed.

13.4 Erosion and Sedimentation

A sediment budget for the watershed.

An update of the landslide and unstable area maps using the most recent aerial photos.

Detailed data on the largest slides and earthflows.

Better soil maps for the Lake and Glenn County portions of the watershed, and an update of the 1977 soil survey of Mendocino County.

Complete weather data, agricultural evapotranspiration data, and stream flow data for several years, so that any future treatments to the watershed can be evaluated and compared to a baseline.

The location and condition of all OHV trails.

13.5 Recreation and Experiential values

High-Priority Needs

An inventory of current scenic conditions (previously termed "existing visual conditions" or EVCs). The lack of a current inventory at the watershed level precludes a current scenic analysis of the watershed in this report, and would also preclude an analysis of cumulative scenic impacts as required for certain projects under NEPA planning (CFR 1507.2). A large-scale fire and timber harvest in the watershed postdate the existing inventory, making an update a priority.

Other Data Needs

Comparable data on numbers of jobs, total personal income, sales, and value-added impacts produced by each of the watershed's commodities.

Further data on the economic impact of commodities, including water, tourism, fisheries, power, alternative forest-based plant products, as well as recreation. These data should be collected and examined in order to give a balanced view of community economic conditions for future planning.

A compilation of references to the watershed in literature, local culture, and historical documents. Intangible value could then be assessed as equally important valuations of the watershed.

A record of the use of the Gravelly Valley airstrip and the airspace around it by type of aircraft. Peak-weekend observations be compared to the 1986 PG&E observations cited in Section 9.4 to establish trends in use.

Figures on use of the Lake Pillsbury access road by vehicle (including trailer) type and number of occupants. These data could be modeled during NEPA planning according to improvement alternatives.

Data on the numbers of OHV event and non-event users, and use of campgrounds by OHV recreationists, in the watershed.

Field observations on recreational activity levels, types of activities, existing use areas, and campground use levels, particularly for peak weekends.

Need for Historical Data

Photographs showing scenic conditions of the watershed's historic landscape exist in the Forest Archaeologist's archives. Those depicting this watershed could be compiled and archived with this document to provide an historic baseline for the Upper Main Eel's scenic landscape.

14.0 MONITORING NEEDS AND WATERSHED ANALYSIS REVISION CRITERIA

The ROD lists numerous monitoring needs and different types of monitoring and provides a commitment to monitoring. Unfortunately, our existing budget is insufficient to support all of the monitoring that the ROD suggests as important. Decisions must be made about what we can afford to monitor within our budget constraints. Each of the following sections generally lists higher priority monitoring first.

New monitoring pursued could utilize partnerships and cooperative agreements. Other agencies such as the California Department of Fish and Game and Department of Water Resources are interested in some or all of these data. Interdisciplinary and interagency partnerships would help focus on monitoring important parameters and help stretch the budget to ensure that the important monitoring is accomplished.

14.1 Anadromous Stocks at Risk and Riparian Ecosystem Function

Fish Surveys

Continue to monitor the community balance between *P. grandis*, steelhead, and salmon. This information would provide fisheries managers with future trends and feedback on our management efforts. Survey and monitor the species abundance and diversity of other nongame fish and how these other species fit into the community structure.

Riparian-Dependent Species of Concern

Survey and monitor the locations, relative abundance, and habitat conditions of the riparian-dependent species of concern listed in Chapter 4.

Recreation

Monitor to ensure that recreational use does not prevent meeting ACS objectives on National Forest System lands. If conflicts are documented, conduct additional monitoring to determine if ACS objectives can be met by adjusting use patterns.

Riparian Grazing Use

Monitor riparian areas, including those areas identified in Chapter 4 as having past conflicts, for stubble height, bank stability, and woody riparian plant use and trends to determine if grazing use meets ACS objectives.

Stream Cross-Sections and Width/Depth Ratios

Conduct stratified sampling of representative sites and stream reaches to provide trend information on erosion, and riparian and fishery habitat conditions.

Riparian Condition and Cover

Establish riparian condition and cover monitoring according to what can be afforded over the long run. The following techniques are listed in order of lowest to highest expected cost:

Establish photo points and take measurements of stream shade and bank cover at key points in the watershed. Key points would have limited riparian vegetation, but a high potential for recovery. This monitoring would provide long-term effectiveness and validation information on our management activities. All riparian enhancement project sites should be so documented prior to work.

Locate historic photographs of known locations in the watershed and establish photo and other monitoring at those locations.

Review land-line survey notes which were begun in the late 1870s. The notes could provide good details about location of wetlands and lakes, meadow width, stream width, and historic plant communities. Document long-term riparian changes and establish monitoring at representative locations.

Establish aerial color-infrared photo studies to provide long-term riparian-trend analysis on the lower river and key tributaries. Riparian vegetation, including herbaceous vegetation, is readily distinguishable in this kind of photo.

Establish riparian video-monitoring via low level flights on the larger streams. Special cameras and computer analysis software are available for this work.

Water Temperature

Monitor water temperature on anadromous tributaries where riparian enhancement project work is planned and where natural recovery is believed to be likely. Air temperatures should be compared with water temperatures to help follow the long-term trend. Stream flows should also be measured at low flow, and more often if possible. New, electronic thermographs could be placed in a number of locations. They are considered affordable and require no inspection or maintenance until summer is over. At that time they can be returned to the office and the data transferred to a computer.

Stream Low-flow Discharge

Measure discharges for anadromous tributaries and streams where large riparian management or vegetation management projects will be pursued. This would provide feedback on project effects and determine if our assumptions are valid. Minimum streamflows usually occur sometime in August or September. These discharges could be compared with discharges from nearby, similar, control subwatersheds where no new work is expected to occur.

Aquatic Macroinvertebrate Sampling

Obtain a baseline of what species, abundance, and biomass exists in key locations throughout the watershed. Resample following future recovery or disturbances to monitor trends.

Other Instream Physical Characteristics

Monitor pool frequency and quality (width, depth, and cover), percent fine sediment, and coarse woody debris. Baseline information has already been collected on most of these. Resample following recovery or future disturbances.

14.2 Threatened, Endangered, and Special Status Species

Late-Successional Reserves

Monitor to determine that LSRs are functioning as designed, and to provide trend data on spotted owl populations within the LSRs. Vegetation should be monitored to ensure that both health and longevity are maintained.

Snags and Downed Woody Debris

Monitor to establish snag densities and amount of downed woody debris currently available. This information is essential in determining that sufficient habitat is available for cavity-nesting species, and that desired levels of both are maintained.

Old-Forest Dependent Species

Monitor these species to determine population densities and reproductive information throughout the watershed. If conducted at this scale, such monitoring could provide baseline data to determine population trends.

Determine where riparian vegetation conditions are not conducive for dispersal of old-forest dependent species. This could lead to additional management or restoration opportunities.

Monitor nesting spotted owls that have OHV trail or road use occurring within one quarter mile of them. This will provide needed information regarding what effects these uses have on spotted owls on this Forest.

TES Plants

Monitor as described in the Proposed LRMP. Monitor selected projects to assure that coordination for protection was followed.

Bald Eagles

Monitor bald eagles at Lake Pillsbury and potential nest sites yearly as described in the Recovery Plan for the Pacific Bald Eagle.

Peregrine Falcons

Monitor natural, enhanced, and potential nest sites yearly to determine occupancy. If occupied, monitor to determine if nesting and reproduction are successful.

Species Listed in Table C-3 of the ROD

Monitor these species as outlined in the ROD, as protocols become available.

14.3 Plant community Community Changes

Forest Vegetation

Monitor vegetation on a 10-year basis to determine growth and occupancy. Reestablish a selected sample of the existing CFI plots to track mortality and ecological changes over time.

Species Listed in Table C-3 of the ROD

Cooperate on a bioregional basis to increase knowledge of the habitat requirements of species that may occur in the watershed.

Downed Woody Material

Collect data on decay rates and DWM accumulation rates so that habitat needs and fuel accumulations can be better predicted over time.

Compare treated and untreated areas to determine effectiveness of landscape level burns.

14.4 Erosion and Sedimentation

Stream Channels

Continue the ongoing Forest Service Stream Channel Stability Evaluations. These evaluations detect changes which occur over a number of years. Several channel profiles are needed to monitor sediment in the channels. This would be very important if vegetation planting occurs in the riparian zone.

Compare burned and unburned drainage systems to assure prescribed fire program analysis is accurately predicting effects.

Erosion

Monitor management activities for BMP implementation and effectiveness.

Establish pin study areas to monitor soil erosion. Location of the pins can be in conjunction with CFI plots.

Slides

Monitor the largest slides for movement. This may require long-range triangulation surveys. Monitor smaller slides which are a threat to roads, lakes, and ponds. The lakes and ponds should be studied to determine seepage loss into the slide.

Sedimentation

Implement a new sediment volume study of Lake Pillsbury to determine changes in rate of sedimentation over time and the effectiveness of erosion control programs.

Monitor turbidity at OHV trail-stream crossings, especially where the hazard rating is high, as shown in Table 16.5-1 (Section 16.5). Monitoring should be done during storm events and, as a lower priority, during OHV events and other weather conditions. Monitoring effectiveness could be increased by supplementing the water sampling with trail soil-loss monitoring.

14.5 Watershed Analysis Revision Criteria

Watershed analysis is an iterative process, not an end point. Decision makers will charter revisions according to future needs. Social values may change or substantial new issues may appear. Monitoring may provide us with new insights into how to better manage our resources. As activities are planned and carried out in the Upper Main Eel watershed, it is likely that new information will be developed and become available for use. Catastrophic events may occur that result in changes in watershed conditions. Any of these changes could trigger a revision.

Portions of the data included in this analysis could be revised and updated as new information becomes available, is analyzed, and provides significant new insight into the processes and interactions occurring within the watershed. The types of "new" information which might necessitate additional or revised analysis could include:

- a catastrophic event such as a wildfire or disease/insect epidemic,
- results of monitoring,
- results of project implementation,
- data from a new resource survey, and
- analysis in a similar watershed which resulted in differing conclusions.

There is no specific schedule for future analysis of this watershed.

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15.2 GIS Information Sources

General Source Information for Maps Included in the Upper Main Eel Watershed Analysis Document

Counties--State of California, Teale Data Center, 1:100,000 scale.

Forest Boundary--Pacific Meridian Resources, digitized from USGS Primary Base Series Maps, 1:24,000 scale, 1993, and Cartographic Feature Files, USDA-FS, 1:24,000 scale, 1993.

Watershed--Calwater coverage from California Department of Forestry, 1:24,000 scale, 1994.

Ownership--USDI, Bureau of Land Management, 1:100,000 scale, 1989, updated with Forest Service administered lands, Pacific Meridian Resources, digitized from USGS Primary Base Series Maps, 1:24,000 scale, 1993.

Wilderness within Mendocino National Forest--Pacific Meridian Resources, digitized from USGS Primary Base Series Maps, 1:24,000 scale, 1993, and Cartographic Feature Files, USDA-FS, 1:24,000 scale, 1993.

Wilderness outside Mendocino National Forest--USDA-FS, 1:63,360 scale, 1985.

Hydrography Layer--Cartographic Feature Files, USDA-FS, 1:24,000 scale, 1993.

Vegetation--Mendocino National Forest, USDA-FS, 1:24,000 scale, 1993.

Interim Riparian Reserves--hydrography as above buffered to distances outlined in Record of Decision, USDI, Bureau of Land Management and USDA-FS, 1994, pp. 9 & C-30, C-31.

Slope class layer (used to calculate horizontal widths for riparian reserves)-- Digital Elevation Model, USGS, 1993.

Transportation Layer--Cartographic Feature Files, USDA-FS, 1:24,000 scale, 1993.

American Indian Ethnography--Mendocino National Forest, USDA-FS, 1973.

Problems With Cartographic Data

Any source information digitized at smaller than 1:24,000 scale impacts overall database accuracy and has an effect on acreage summaries resultant therefrom.

Cartographic Feature Files (CFF) are digital representations of all features on USGS Primary Base Series (PBS) maps, and as such, may tend to understate the number of mapped features, especially in the case of hydrography and transportation. For example, PBS maps may show only 40 percent of existing stream courses. And, due to the complexity of mapped features, some coding errors may exist in the data.

CFF line segments coded as "intermittent lakes" which were less than one acre were treated as wetlands less than one acre for purposes of creating buffer distances for interim riparian reserves.

There were numerous problems of edge-matching in the vegetation information resulting in vegetation polygons whose edges, in some cases, follow quad boundaries.

15.3 Other Information Sources

Many additional sources were located and reviewed, including numerous Forest Service and California Department of Fish and Game stream surveys. Lists of these source documents and where they can be found are located in the Upper Main Eel watershed analysis report file. This file will be stored in the Ecosystem Management files in the Supervisor's Office.

16.0 APPENDICES

16.1 List of Watershed Analysis Team Members and Others Consulted

Interdisciplinary Core Team

Name	Discipline	Agency
Melissa Marosy	Watershed Analysis Team Leader, Editor	Forest Service
Vic Andresen	Geologist/Hydrologist	Forest Service
Jim Harvey	Vegetation Management Specialist	Forest Service
Lee Morgan	Fishery Biologist	Forest Service
Mike Ramsey	Wildlife Biologist	Forest Service
Claudia Stuart	Landscape Architect	Forest Service

Other Interdisciplinary Team Members

Name	Discipline	Agency
Blaine Baker	Upper Lake District Ranger	Forest Service
John Brooks	Geologist	Forest Service
Amedee Brickey	Fish & Wildlife Biologist	FWL Service
Dan Brown	Soil Scientist	Bureau of Land Management
David Hartman	GIS Coordinator	Forest Service
Janet Flanagan	Eastside Planning Team Leader	Forest Service
Karen Fukushima	Cartographic Technician	Forest Service
Emil Ekman	Fishery Biologist	Forest Service
Bob Faust	Hydrologist	Forest Service
Nancy Gard	Westside Zone Planner	Forest Service
Jim Giachino	Stonyford District Ranger	Forest Service
Greg Greenway	Archaeologist	Forest Service
David Isle	Botanist	Forest Service
Arnold James	Soil Scientist	Forest Service
Chirre Keckler	Wildlife Biologist	Forest Service
Michelle Light	Land Management Planner	Forest Service
Bob McCabe	Forester	Forest Service
Colleen Pelles	Forest Wildlife Biologist	Forest Service
Anne Reese	Wildlife Biologist	Forest Service
Dianne Rubiaco	Fuels Management Specialist	Forest Service
Bob Wick	Recreation/Wilderness	Bureau of Land Management
Les Gonyer	Hydrologist	Forest Service

Other Professionals Consulted

Name	Discipline	Agency
Ken Aasen	Fishery Biologist	CA Dept. of Fish and Game
Jeff Applegate	Recreation Technician	Forest Service
Jack Booth	Wildlife Biologist	CA Dept. of Fish and Game
Greg Bryant	Fishery Biologist	Natl. Marine Fishery Svc.
Jim Bybee	Fishery Biologist	Natl. Marine Fishery Svc
Scott Downey	Fishery Biologist	CA Dept. of Fish and Game
John Emig	Fishery Biologist	CA Dept. of Fish and Game
Gene Geary	Fishery Biologist	PG&E
Allan Grass	Fishery Biologist	CA Dept. of Fish and Game
Royce Gunter	Fish Hatchery Manager	CA Dept. of Fish and Game
Nora Hamilton	Recreation Technician	Forest Service
Brett Harvey	Research Fishery Biologist	Forest Service
Weldon Jones	Fishery Biologist	CA Dept. of Fish and Game
Amy Lind	Research Wildlife Biologist	Forest Service
Sheila Logan	Ecologist	Forest Service
Gerry Mohl	Implementation Officer	Forest Service
John Mullin	Game Warden	CA Dept. of Fish and Game
Lori Pacheco	Range Technician	Forest Service
Steve Sayers	Forester	CDF
Tom Schott	Soil Scientist	Soil Conservation Service
Rich Stafford	Forest Road Manager	Forest Service
Park Steiner	Fishery Biologist	PG&E Consultant
Mike VanDame	Range Conservationist	Forest Service
Larry Week	Fishery Biologist	CA Dept. of Fish and Game
Harry Zabel	Road Manager	Forest Service

The core team extends apologies to anyone who contributed to this effort whose name we inadvertently overlooked when preparing the above lists.

16.2 Aquatic Conservation Strategy Objectives (from ROD Page B-11)

Forest Service and BLM-administered lands within the range of the northern spotted owl will be managed to:

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted.

2. Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

5. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

6. Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.

7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

9. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.

16.3 Answers to Questions in Appendix C of the FY 94-96 Watershed Analysis guidelines

This section answers questions listed in Appendix C of the FY 94-96 Watershed Analysis Guidelines pertaining those T&E species identified in Chapter 5 as occurring in this watershed; the questions regarding amphibians are answered in Chapter 4.

Northern Spotted Owl

1. Are spotted owl activity centers located within the watershed? If so, how many and in what ROD land allocations are they located? Which of these are currently above "take" thresholds and which are below? When were the activity centers located? Describe the reproductive history.

Owl locations have been mapped for the Forest, but the activity centers have not been designated yet. Until activity centers are designated, more detailed land allocations cannot be given, and analysis for above and below "take" cannot be conducted. It should be noted that "take" analyses conducted in the past on the Forest have generally been below "take". The owl numbers listed as having activity centers due to pair or territorial single status are those that are known or thought to meet the the criteria at the time this document was written. There may be additional information that was not located during this analysis. If additional information is found that would allow designation of an activity center, it is recommended that it be used following the guidelines in the ROD.

LSR RC313

Inside Watershed Boundary

Owl number 4020: pair located in 1982, male and female within 1/4 mile of each other.

Owl number 4037: pair located in 1982, unconfirmed pair.

Owl number 4022: pair located in 1992, reproduced in 1992.

Owl number 4023: pair located in 1982, moved in 1989, reproduced in 1989, 1991, 1992.

Outside Watershed Boundary

Owl number 3019: pair located in 1988 non-nesting, reproduction in 1992, singles located in 1989, 1990, 1991.

Owl number 3054: male and female located in 1982, unconfirmed pair on the northeast boundary of the LSR.

Owl number 3003: male located twice in 1992.

Owl number 3018: male located once in 1974 and twice in 1992.

While surveyed in 1991 and 1992, additional area was added between HCA 21 and HCA 22 in 1994 to create LSR RC313, and it is not currently known whether or not the additional area may have been surveyed during 1991 and 1992 for timber sales. However, calling results do not show any additional owl observations. The additional area does not contain much dispersal or nesting habitat.

Summary: 8 activity centers; inside the watershed 4 pairs and 0 territorial single activity centers, outside the watershed 2 pairsand 2 territorial single activity centers.

LSR RC312

Owl number 4024: pair located in 1986 non-nesting, reproduced in 1992.

Owl number 4044: pair located in 1992 non-nesting.

Owl number 4017: pair located in 1982, reproduction in 1986, 1988, 1990, 1992 , non-nesting 1982, 1983, 1985, 1987, 1989, single in 1994.

Owl number 4015: pair located 1987, non-nesting 1987, 1989, singles located 1986, 1991, 1994.

Owl number 4047: pair located 1987, non-nesting 1987 and 1992.

Owl number 4014: pair located 1987, 2 single males in 1992.

Owl number 4033: territorial single male located twice in 1990, once in 1992, and twice in 1994.

Owl number 4043: territorial single located twice in 1991. The Upper Lake District has identified this as an activity center based on information that the Supervisor's Office has not yet located or received from the District.

Owl number 4019: territorial single located in 1990, 1991, 1994. The Upper Lake District has identified this as an activity center based on information that the supervisors office has not yet located or received from the District.

Summary: 9 activity centers, 6 pairs and 3 territorial singles.

LSR RC315

Inside Watershed Boundary

Owl number 4012: pair located in 1987, reproduction in 1987, non-nesting 1989, 1990.

Owl number 4009: pair located 1982, moved in 1988, non-nesting 1982, 1988, 1990, reproduction in 1989.

Owl number 4042: pair located in 1991 non-nesting, reproduction in 1992.

Outside Watershed Boundary

Owl number 4011: pair located in 1990 non-nesting.

Owl number 4010: male and female located about 1 mile apart at night, unconfirmed pair. California Department of Fish and Game has additional information which would support this finding. We are in the process of collecting this information.

Owl number 4007: pair located in 1983 unconfirmed pair, moved in 1988, non-nesting in 1988, 1989, reproduction 1990.

Owl number 4005: pair located 1987 non-nesting, singles located in 1982, 1986.

Summary: 7 activity centers; inside watershed boundary 3 pair, 0 territorial single activity centers. Outside watershed boundary 4 pair, 0 territorial single activity centers.

LSR RC311

Owl number 3060: pair located 1982, 1 male 1991.

Owl number 3014: pair located 1988, reproduction 1988, 1989, 1990, 1992.

Owl number 4004: pair located 1986, singles located in 1982.

Owl number 4054: pair located 1981, no other information.

Owl number 3049: singles observed in 1982, pair with reproduction in 1992.

Owl number 3011: pair located 1991, singles located in 1982.

Owl number 3016: pair located 1987, non-nesting 1987, 1989, reproduction 1988, 1992.

Owl number 3015: singles observed in 1982, reproduction in 1992.

Owl number 3050: territorial single located 1990, 1991, 1992.

Owl number 3010: territorial single located 1990, 1992.

Summary: 10 activity centers; 8 pairs and 2 territorial singles.

Snow Mountain Wilderness

Inside Watershed Boundary

Owl number 4030: territorial single female located 1989.

Outside Watershed Boundary

Owl number 3040: pair located 1987, no other information.

Owl number 3038: territorial single located in 1988, 1989.

Summary: 3 activity centers; inside watershed 0 pairs and 1 territorial single. Outside watershed 1 pair and 1 territorial single.

Matrix

Owl number 3043: pair located 1991, reproduction 1991, non-nesting 1992.

Owl number 3044: pair located 1991, reproduction 1992, non-nesting 1991.

Owl number 3045: pair located 1991, unconfirmed, singles 1992.

Owl number 3046: pair located 1991, reproduction 1991, 1992, singles in 1990.

Owl number 3051: pair located 1982, unconfirmed, unconfirmed pair 1983, singles in 1986.

Owl number 4025: territorial single located in 1989, no other information.

Summary: 6 activity centers; 5 pairs and 1 territorial singles.

2. Has a 100-acre core area been designated around each activity center located in matrix lands?

As of yet, 100-acre core areas have not been designated for the activity centers that occur in the matrix.

3. How many acres of nesting, roosting and foraging (NRF) habitat are there in the watershed? What percent of the watershed is this? Which of these stands have been surveyed to protocol? Which have not? (Protocol requires a 2-year survey of 3 visits each year).

4. What is the amount of NRF habitat in each ROD land allocation within the watershed?

Nesting and roosting habitat have been defined the same for this Forest. Nesting and roosting habitat is currently defined as being M4G and M6G vegetation types. (It should be noted that Forest combined M4G, M4N, M5G and M5N timber types to create M4G timber strata, which is the vegetation information in the Forest GIS system.) Additional nesting and roosting which have not been identified yet may occur in other vegetation types in this watershed. Not all M4G vegetation types contain the habitat characteristics that contribute to suitable nesting habitat. This could be verified at the site-specific level if it is needed.

There are 19,802 acres of nesting and roosting habitat in this watershed, and this is approximately 9 percent of the federal land within the watershed.

Table 16.3-1. ACRES OF SUITABLE NESTING AND ROOSTING HABITAT BY LAND ALLOCATION

Land Allocation	Acres of M4G, M6G
LSR RC311	7011
LSR RC312	2546
LSR RC313	2430
LSR RC315	2222
Wilderness	1006
Riparian Reserves	2810
Matrix	1775
RNA	0
RNA in LSR RC313	7

5. Does any portion of the watershed contain LSRs? (What percent of the total watershed is this?) What are the current totals of NRF habitat and "capable" habitat in the LSR?

This watershed is approximately 35 percent LSR. The current totals of nesting and roosting habitat in each LSR (that portion within this watershed) is shown in Table 16.3-1 above. Attempting to calculate "capable" habitat was not done.

6. What is the amount of dispersal habitat (11/40 and above, depending on site-specific knowledge) in each ROD land allocation within the watershed?

The following assumptions were made to determine the amount of dispersal habitat that met 11/40 and above: vegetation that did not meet 11/40 and above in 1979, when the vegetation was mapped, was not included; only vegetation that was thought to meet 11/40 was included; and vegetation types included M3G, M4G, M6G, and C4X. The Proposed Forest LRMP includes a percentage of M2G timber strata that is believed would meet 11/40 based on sampling information. While this would be appropriate at the Forest scale, it is not appropriate at the smaller watershed scale, which is more site specific. Not all C4X vegetation type provides dispersal habitat, but it is generally considered to meet the definition. This could be verified at the site specific level if needed. As a result of these assumptions and calculation methods, there may be additional areas that meet 11/40 or serve as dispersal habitat that were not identified, and the acreages may be underestimated.

It is estimated that 18 percent (41,191 acres) of the federally owned lands within this watershed meet or exceed 11/40.

Table 16.3-2. ACRES OF SUITABLE DISPERSAL HABITAT BY LAND ALLOCATION

Land Allocation	Acres
LSR RC311	13462
LSR RC312	4556
LSR RC313	3180
LSR RC315	3038
Wilderness	2173
Riparian Reserves	8843
Matrix	5938
RNA outside LSR RC313	1

7. Is distance between LSRs (those LSRs over 10,000 acres in size) greater than 4 miles? (This determination may require analysis beyond the watershed.) If so, then what is the amount of dispersal habitat on Federal lands for all 1/4 townships between the LSRs? What percent of the total Federal lands in these 1/4 townships is this?

How much (percent and total acres) of the dispersal habitat is in Riparian Reserves, Administratively Withdrawn Areas (for those areas which may provide long-term protection), Congressionally Reserved, 100-acre cores, and other smaller (<10,000-acre) LSRs? Is this total greater than 50%? Describe, if

present, the natural barriers to dispersal. Is connectivity, or dispersal habitat, sufficient to allow movement?

The distance between LSR RC313 and RC311 is greater then 4 miles; however, there is an administratively withdrawn area between these two LSRs which makes the effective distance less than 4 miles.

The distance between LSR RC312 and LSR RC313 is greater than 4 miles; however, there are LSRs or congressionally withdrawn areas to the north of each of these LSRs. The amount of dispersal habitat on federal lands within this watershed for all quarter-townships between these LSRs is approximately 537 acres. This is 3 percent of the total Federal lands in these townships. The lack of dispersal habitat between LSRs RC312 and RC313 is the result of naturally occurring chaparral fields, and past management activities may have contributed to this condition. There may also be a small amount of vegetation that would contribute to dispersal outside of the four townships analyzed, but it is not thought to be a significant amount.

8. How much critical habitat has been designated within the watershed? How much of this total overlaps with LSRs? For areas that do not overlap, how much is currently NRF habitat, how much is "capable"? How many activity centers are located in this "non-overlap" area of CHU? How many are currently above "take", how many below? What role does this "non-overlap" critical habitat play in this watershed (and/or larger scale) in relation to the reasons for the designation of the CHU?

There is approximately 66,665 acres of critical habitat in the watershed (30 percent of the total watershed). 65,845 acres (99 percent) of the critical habitat overlaps with LSRs. For the areas that do not overlap (approximately 820 acres), the acres of nesting habitat, and vegetation capable of becoming nesting, are not currently known. There are no known activity centers located in this non-overlap area of critical habitat. The role of this non-overlap critical habitat in this watershed is unknown at this time.

Bald Eagle

1. Are occupied bald eagle activity areas (nesting areas, foraging areas, winter roosts, or concentration areas) located within the watershed? If so, what type, how many, and in what ROD land allocations are they located? Describe the reproductive history based on monitoring data. Has a final site-specific protection/management assessment been developed for each site? Does this watershed analysis corroborate the findings of the management assessment?

There is a bald eagle activity area located within this watershed at Lake Pillsbury. This activity area includes a nesting area, foraging area, and a wintering area, which all occur within a riparian reserve (Lake Pillsbury and its tributaries). A habitat management plan for the bald eagles at Lake Pillsbury was written in 1979. The habitat management plan is scheduled to be revised in 1995.

2. Has an assessment been made as to whether there are "potential" bald eagle activity areas (nesting, foraging, winter roost, or concentration areas) located within the watershed? ("Potential" would mean the habitat components appear sufficient, but the area is unoccupied, or has not been surveyed.) If yes, what type, how many, and in what ROD land allocations are they located? Have these areas been surveyed to protocol to determine they are unoccupied?

There has not been an assessment made to determine if there are other potential bald eagle activity areas in this watershed.

3. Describe historical bald eagle occurrence and nesting within the watershed.

Bald eagle nesting information has been recorded for Lake Pillsbury since 1967, and bald eagles have been reported in the area since 1935; however, there is no information on numbers or activities prior to 1967.

Table 16.3-3. BALD EAGLE REPRODUCTION AT LAKE PILLSBURY

YEAR	Number of Young Fledged	Nest Active?
1967	0	Yes
1970	unknown	unknown
1971	2	Yes
1972	unknown	Yes
1973	0	No
1974	1	Yes
1975	1	Yes
1976	0	No
1977	2	Yes
1978	2	Yes
1979	0	No
1980	0	No
1981	2	Yes
1982	2	Yes
1983	0	abandoned
1984	0	abandoned
1985	2	Yes
1986	1	Yes
1987	0	Yes
1988	2	Yes

Table 16.3-3. BALD EAGLE REPRODUCTION AT LAKE PILLSBURY (continued)

YEAR	Number of Young Fledged	Nest Active?
1989	unknown	unknown
1990	2	Yes
1991	unknown	Yes
1992	unknown	Yes
1993	0	Yes
1994	1	Yes
1995	too early	Yes

4. What is the status of the watershed as it relates to the Recovery Plan? (Target Recovery territories, etc. Analyses may need to extend beyond the watershed boundaries.) Does the watershed and the surrounding area meet the objectives of the Recovery Plan? If not, then:

Are there "capable" bald eagle activity areas located within the watershed? ("Capable" would mean that many but not all of the habitat components are present, yet the site could become "potential" through enhancement, restoration, or time.) If "capable" activity areas are present, what type are they, how many, and in what ROD land allocations are they located? What type of project or enhancement could be proposed that could help develop the sites into "potential" or "occupied" sites?

The first surveys in March 1995 indicate that there are two occupied territories, and a third potential occupied territory, at Lake Pillsbury. How Lake Pillsbury contributes to bald eagle recovery was not found in the recovery plan, so a relationship could not be established. The Proposed Forest LRMP indicates that the Forest should support three nesting bald eagle pairs.

It is not currently known if there are other capable areas in this watershed.

5. If present, describe the "significant habitat" within the watershed that is currently not under Federal ownership.

There currently is some private ownership of land that includes the lake edges. Additionally, Scott Dam is owned by PG&E and is regulated by the Federal Energy Regulatory Commission.

Peregrine Falcons

1. Are any cliffs located within the watershed as determined by topographic maps, aerial photographs *and* ground/air reconnaissance? (A cliff is defined as a rock wall or outcrop which has a total height of 60 feet or more.)

Two enhanced ledges and one hack box are known to exist within this watershed.

The only known historic eyrie in the watershed was destroyed during the construction of Scott Dam. There are no known traditional eyries located in this watershed.

2. Are any cliffs within the area of watershed analysis historic (pre-1975) or traditional (post-1975) peregrine falcon eyries?

Since there are no historic or traditional eyries located within the watershed, site-specific variables can not be discussed.

3. For past projects near historic cliffs, have mitigation measures for habitat surrounding cliffs been considered, and have surveys to protocol (Pagel 1992) been accomplished for at least two years prior to the activities?

Since there are no historic cliffs, these have not been done.

4. For traditional cliffs, have surveys or monitoring been conducted to determine nest site, occupancy, and reproductive success; and has a draft or final site-specific protection/management plan based on site-specific and PNW sub-population nesting ecology been created?

Some areas were surveyed in 1989, 1982-84, and 1991, although no peregrines were found in this watershed. Site-specific protection/management plans have not been established for traditional cliffs.

5. Have the cliffs located within the watershed been rated/monitored for peregrine falcon potential/ presence?

The cliffs in this watershed have been rated for peregrine falcon potential. The cliffs in this watershed have not been monitored annually for the presence of peregrine falcons.

6. If cliffs are un-rated, have surveys to protocol (Pagel 1992) been accomplished?

7. Describe site-specific habitat variables within a 3-mile radius of historic and traditional nest sites. Habitat variables include: cliff parent material; distance to lacustrine, marine or riparian systems; plant associations and related seral stages; and human-generated activities. Habitat variables should be displayed on GIS using standard methodology among agencies.

There are no known active eyries in this watershed.

16.4 Attachment C of Table C-3 Species List

The following is a list of those species listed in Attachment C of Table C-3 of the ROD that have the potential to occur on the Forest. This list should not be considered complete as information about these types of species is limited, but expanding, and species may be added or deleted as more information becomes available. See Attachment C of ROD Table C-3 for more specific family groupings.

Fungi

Tylopilus pseudoscaber
Boletus haematinus
Boletus pulcherrimus
Gautieria otthii
Leucogaster citrinus
Rhizopogon brunneiniger
Rhizopogon flavofibrillosus
Destuntzia fusca
Destuntzia rubra
Cantharellus cibarius
Cantharellus subalbidus
Cantharellus tubaeformis
Gomphus bonarii
Gomphus clavatus
Gomphus floccosus
Gomphus kauffmanii
Cantharellus formosus
Ramaria abietina
Ramaria araiospora
Ramaria botryis var. *aurantiiramosa*
Ramaria concolor f. *tsugina*
Ramaria coulterae
Ramaria fasciculata var. *sparsiramosa*
Ramaria gelatiniaurantia
Ramaria largentii
Ramaria rubella var. *blanda*
Ramaria rubrievanescens
Ramaria rubripermanens
Ramaria suecica
Ramaria thiersii
Ramarua amyloidea
Ramaria aurantiisiccescens
Ramaria celerivirescens
Ramaria claviramulata
Ramaria concolor f. *marri*
Ramaria cyaneigranosa
Ramaria hilaris var. *olympiana*
Ramaria lorithamnus
Ramaria maculatipes
Ramaria rainierensis
Ramaria rubribrunnescens
Ramaria stuntzii
Ramaria verlotensis

Ramaria gracilis
Ramaria spinulosa
Phaecollybia attenuata
Phaecollybia californica
Phaecollybia carmanahensis
Phaecollybia dissiliens
Phaecollybia fallax
Phaecollybia gregaria
Phaecollybia kauffmanii
Phaecollybia olivacea
Phaecollybia oregonensis
Phaecollybia piceae
Phaecollybia pseudofestiva
Phaecollybia scatesiae
Phaecollybia sipei
Phaecollybia spadicea
Cortinarius verrucisporus
Cortinarius wiebeae
Albatrellus ellisii
Albatrellus fletti
Albatrellus avellaneus
Hydnum repandum
Hyndum umbilicatum
Phellodon atratum
Sarcodon fuscoindicum
Sarcodon imbricatus
Glomus radiatum
Baeospora myriadophylla
Chrysomphalina grossula
Collybia bakerensis
Fayodia gracilipes (rainierensis)
Gymnopilus puntifolius
Marasmius applanatipes
Mycena hudsoniana
Mycena lilacifolia
Mycena marginella
Mycena monticola
Mycena overholtsii
Mycena quinaultensis
Mycena tenax
Mythicomyces corneipes
Pholiota albivelata
Stagnicola perplexa
Clitocybe subditopoda
Clitocybe senilis
Bondarzewia montana
Aleurodicsus farlowii
Dichostereum granulosum
Cudonia monticola
Gyromitra californica
Gyromitra esculenta
Gyromitra infula
Gyromitra melaleucoides

Gyromitra montana (syn. *G. gigas*)
Otidea leporina
Otidea onitica
Otidea smithii
Plectania melastoma
Podostroma alutaceum
Sarcosoma mexicana
Sarcosoma eximia
Spathularia flavida
Aleuria rhenana
Helvella compressa
Helvella crassitunicata
Helvella elastica
Helvella maculata
Clavulina cinerea
Clavulina cristata
Clavulina ornatipes
Phytoconis ericetorum
Asterophora lycoperdoides
Sparassis crispa

Lichens

Bryoria tortuosa
Ramalina thrausta
Usnea longissima
Beullia oidalea

Bryophytes

Kurzia makinoana
Ptilidium californicum
Scouleria marginata
Ulota meglaspora

Mollusks

Helminthoglypta hertleini

Vascular Plants

Botrychium minganense
Cypripedium fasciculatum (Klamath)
Cypripedium montanum (West Cascades)

Arthropods

Canopy herbivores (south range)
Coarse wood chewers (south range)
Litter and soil dwelling species (south range)
Understory and forest gap herbivores

Bats

Fringed myotis
Silver-haired bat
Long-eared myotis
Long-legged myotis
Pallid bat

16.5 Geology of the Upper Main Eel Watershed

Geological Origin

The Upper Main Eel watershed lies completely on the Franciscan Terrain of the Coast Range. The Franciscan Terrain had its origin in the late Jurassic to Eocene (140-50 m. y.), when oceanic crust was subducting under the western edge of the North American continent at an oceanic trench. During subduction, sediments deposited on the oceanic floor and in the trench are scraped off against the overriding crust. Along with the sediments, sea mounts (undersea volcanos), atolls, and lava beds were also scraped off. When a major obstruction such as a sea mount, atoll, ridge, or fracture zone collides with the over-riding crust, the descending oceanic crust often breaks and large slabs of oceanic crust, atolls and sea mounts become incorporated into the material being scraped off.

Much of the sedimentary material scraped off the descending plate is made up of thin beds of sandstone, shale and bedded radiolarian chert. The bedded radiolarian chert is often interbedded with shale, or as thin beds on subsea lavas. Sometimes the chert can be deposited in thick massive beds hundreds of feet thick. Within the trench, turbidite deposition (beds of sandstone and shale) occur on top of the sediments riding on the oceanic crust. The sediments are carried to various depths by riding on the descending oceanic crust. The sediments scraped off early in plate descent will remain unaltered and very soft. Other sediments carried to greater depths will be exposed to a high pressure-low temperature metamorphosing condition. Some of the minerals found in the drainage will only form at depths greater than 80,000 feet (Cloos 1986). The fine clays that make up the shales will dehydrate during metamorphism to form a new variety of clay minerals, while the chert and sandstone will re-crystallize into a fine crystalline quartz. The intensity of metamorphism and the composition of the original material will determine the rate at which the material will weather and erode.

Sea mounts (undersea volcanos) and other mafic (rich in iron, magnesium and poor in calcium and silicon) lava flows when carried down into the high pressure low temperature zone will be metamorphosed, in the presence of water, into rocks called greenstones. Portions of the broken slabs of oceanic crust will metamorphose in the presence of water to form the ultramafic rocks known a serpentine. The whole mass of sediments, sea mounts, slabs of oceanic crust, and atolls is called a melange. As it is accumulating, large portions of the melange are under compressional stresses. Faulting, folding and shearing occurs in the serpentine and the softer clay units, while the thicker, more competent units will remain intact but get tipped at various angles.

Present Geological Conditions

Subduction off the coast and west of the Mendocino National Forest has ended. The material that accumulated in the melange is now subjected to a combination of strike-slip and compressional forces. The strike-slip forces are well known and are the cause of the San Andreas fault and its subsidiary faults which penetrate through the Coast Range. The Bartlett Springs Fault Zone which crosses through the study area is one of these subsidiary faults. Strike-slip faults zones tend to be made up of several parallel faults. The parallel faults can be as close as a few yards and up to several miles apart. Movement along the parallel faults can be concentrated on one fault and several miles away the movement will shift and be concentrated on another parallel fault. Depending on the direction of movement and which parallel fault moves, the zone between them can be stretched and downdropped or squeezed and uplifted. Gravelly Valley, in which a portion of Lake Pillsbury sits, is a down-dropped block between parallel faults. East-west compressional forces are also present. These compressional forces usually result in low angle reverse faults or thrust faults and, along with the strike slip faults, cause the uplift of the linear coast ranges. Unfortunately, surface traces of the low angle reverse or thrust faults are often buried under alluvium. One of these buried faults, running from Fairfield to Capay, was the center of two strong earthquakes which struck on April 19, 1892 and April 21, 1892. These earthquakes destroyed the towns of Winters, Dixon and Vacaville. Movements along this, and similar faults.

formed the first low hills found along the west margin of the Sacramento Valley (Unruh et al. 1995). They are part of a system of faults which are elevating the coast range.

The South Fork Mountain Shist is along a portion of the east side. The South Fork Mountain Shist is a foliated metagraywacke, metamudstone, of intermediate grade metamorphism. Included in this bedrock are blocks of volcanic rock and serpentine (Lehman 1974). This bedrock is fairly resistant to erosion and forms some of the bedrock that underlies the higher peaks on the east side of the drainage. The Bald Mountain Schist is similar to the South Fork Mountain Shist and forms the mountainous ridge northwest of Hull Mountain (Lehman 1974). The Snow Mountain Volcanic Complex is composed mainly of basalts, volcanic breccia, chert, and serpentine. Etter (1979) interpreted this complex to be a seamount (underseas volcano) that was incorporated into the melange material.

Blue Slides Formation is one of several serpentine units within the drainage. Serpentine is formed by metamorphism of volcanic oceanic crust. Thick serpentine units have very limited structural strength and tend to move by plastic flow. Few plants can live on serpentine bedrock because of the high concentrations of iron, magnesium, and toxic microelements along with limited available calcium. These nutrient conditions have resulted in adaptation of some plant species to very site-specific conditions. Since these areas tend to be isolated, this adaptation has resulted in many of these plants having very limited distribution.

The South Fork Mountain Schist, Bald Mountain Shist, and Snow Mountain Volcanic Complex have been thrusted over the younger Grindstone Creek Formation, Poison Rock Melange, and the Hull Mountain Graywacke (Etter 1979). The younger rocks are not as intensely metamorphosed and have more sedimentary clays, shales, and friable sandstones. The underlying rocks are easier to erode than the overthrusted units. The streams draining the overthrusted rocks have a low gradient until they flow onto the subthrust rocks, which are easily eroded. An example of this is the Eel River in Section 24, Township 20 N, Range 10 W, where the river drops from 5,000 feet to 4,000 feet in less than a mile.

The Elk Mountain Sequence is located on the southwest side of the Bartlett Springs Fault Zone. This sequence is composed of graywacke, shale, chert, scattered volcanic rocks and patches of serpentine. This sequence has been divided into subareas based on a number of lithologic, metamorphic grades. Since many of the individual units are faulted and sheared, their positional relationship is hard to determine. Many of the sequences show that they have been strongly metamorphosed to the blueshist facies, a very high pressure, low temperature rock (Etter 1979).

Source of the Turbidity

When volcanic rocks weather they will usually produce montmorillonite and vermiculite clays. Bentonite is mainly composed of montmorillonite and vermiculite and is found in the soils that form on volcanic bedrock. Montmorillonite and vermiculite are both layered clays which have a charge developed between the layers. These charges can be compensated by soluble cations the most common of which are calcium, sodium, and hydronium ions, which can be adsorbed between the layers. The mafic bedrock has a limited supply of soluble Ca, Na, and K, resulting in clays with unsatisfied electrical charge. A potential cation which can satisfy the clay charge is the hydrogen ion, of an acid solution. There are natural springs in the watershed that produce, in combination with photosynthetic activity, an alkaline (high pH) water. Data collected by the State Department of Water Resources show that deeper waters in Lake Pillsbury in May have pH's of 7.3 to 8.4 while the pH's in September will range from 8.5 to 8.7. The high pH's will preserve the charge on the montmorillonite and vermiculite clay layers. The charge can be partially satisfied by the attraction of dipolar water onto the clay surfaces. This results in the clays expanding when placed in water and remaining in suspension for long periods of time. When very high concentrations of montmorillonite occur in solution a gel-like suspension develops.

Another common clay that is found in the watershed is chlorite. Chlorite is an important clay mineral found in the low grade metamorphosed schists (Lehman 1974) and in sedimentary rocks (Etter 1979). Other clays minerals found in sedimentary rocks are white mica and pumpellyite (Etter 1979). These clay minerals have sheet-like structures that tend to keep them in suspension when there is any turbulence in the water.

These naturally occurring clays will remain in suspension for long periods of time and detract from the visual quality of the water. The actual volume and/or weight of material in suspension is very small. These clays can also be a challenge when treating the water for domestic consumption.

Soil Types

Table 16.5-1 lists the soil mapping units found in the Upper Main Eel watershed, along with their erosion hazard, area, and percent occupancy. The types are based on USDA Soil Conservation Service's Soil Survey of Lake County (1989) classifications, and the erosion hazard ratings are those of the Forest Service. The sum of the areas does not match the area indicated in Section 1.1 for the watershed. This is because (1) the area up to the high water level of Lake Pillsbury is excluded; and (2) the area data came from two sources. About three-fourths of the area data is from Brooks et al. (1984); the remainder was calculated using GIS.

Table 16.5-1. SOIL TYPES, SLOPES, AND HAZARD RATINGS WITHIN THE UPPER MAIN EEL WATERSHED

Soil Name	Slope	Hazard	Acres	Percent
Bamtush-Neuns	15-30	Mod	10021	4.81
Bamtush-Speaker-Sanhedrin	30-50	Mod	5802	2.79
Bamtush-Speaker-Sanhedrin	50-75	High	4574	2.20
Deadwood-Sheetiron	50-75	Mod	2415	1.16
Freezeout-Yollabolly	30-50	Mod	2440	1.17
Freezeout-Yollabolly	50-75	High	191	0.09
Jafa Complex	5-30	Low	2840	1.36
Mayman-Etsel-Mayacama	15-30	High	348	0.17
Mayman-Etsel-Mayacama	30-75	High	10439	5.02
Mayman-Etsel-Snook	15-30	High	457	0.22
Mayman-Etsel-Snook	30-75	High	18941	9.10
Mayman-Etsel-Speaker	30-50	High	8832	4.24
Mayman-Hopland-Etsel	15-30	High	1108	0.53
Neuns-Bamtush-Deadwood	30-50	Mod	40	0.02

Table 16.5-1. SOIL TYPES, SLOPES, AND HAZARD RATINGS WITHIN THE UPPER MAIN EEL WATERSHED (continued)

Soil Name	Slope	Hazard	Acres	Percent
Neuns-Decy-Sanhedrin	30-50	Mod	3238	1.56
Neuns-Sanhedrin-Deadwood	30-50	Mod	24263	11.66
Neuns-Sanhedrin-Deadwood	50-75	Mod	4217	2.03
Neuns-Sanhedrin-Speaker	30-50	Mod	4981	2.39
Neuns-Sheetiron-Deadwood	30-50	Mod	15372	7.39
Neuns-Sheetiron-Deadwood	50-75	High	380	0.18
Neuns-Speaker	15-30	Mod	635	0.31
Okiota-Henneke	5-30	High	43	0.02
Okiota-Henneke-Dubakella	15-50	High	3635	2.00
Pomo-Bressa	15-50	Mod	33	0.02
Rock outcrop-Etsel-Snook	50-80	High	42	0.02
Sanhedrin-Kekawaka-Speaker	15-30	Mod	1917	0.92
Sanhedrin-Kekawaka-Speaker	30-50	Mod	20644	9.92
Sheetiron-Deadwood	30-50	Mod	8621	4.14
Sheetiron-Deadwood	50-75	High	19992	9.61
Shortyork V-Yorkville-Squawrock	15-50	High	1390	0.67
Speaker-Marpa-Sanhedrin	30-50	Mod	1522	0.73
Speaker-Mayman-Marpa	30-50	Mod	6957	3.34
Speaker-Sanhedrin	50-75	High	3484	1.67
Speaker-Sanhedrin-Maymen	30-50	Mod	463	0.22
Speaker-Speaker,V-Sanhedrin	5-30	Mod	1508	0.72
Squawrock-Shortyork,V	15-30	Mod	4	0.00
Still-Talmage	2- 8	Mod	420	0.20

Table 16.5-1. SOIL TYPES, SLOPES, AND HAZARD RATINGS WITHIN THE UPPER MAIN EEL WATERSHED (continued)

Soil Name	Slope	Hazard	Acres	Percent
Tyson-Neuns	30-75	High	1482	0.71
Xerofluvents-Riverwash	0- 2	Low	3367	1.62
Yollabolly-Freezeout	30-50	Mod	2419	1.16
Yollabolly-Rockoutcrop-Freezeout	50-75	High	2682	1.29
Yorktree-Hopeland-Squawrock	15-50	High	2519	1.21
Yorkville-Yorktree-Squawrock	15-50	High	2843	1.37

Kelsey's Studies of Redwood Creek and the Van Duzen River Basin

Landslide studies in the Redwood Creek drainage by Kelsey (1988) give an indication of the role slides play in the sediment budget of a drainage basin. Since Redwood Creek drainage is geologically very similar to the Upper Main Eel watershed, the findings should be applicable to the Upper Main Eel. Kelsey showed, using a cumulative slide volume to slide frequency analysis, that the majority of the slide material was in the few largest slides. As a result only about 1 percent of the basin contributed over 30 percent of the debris in the channel. Sixty percent of the slide material came from the largest 10 percent of the slides, and 5 percent of the material came from the smallest 53 percent of the slides. Kelsey discovered from landslide scars that the largest landslides are due to single events, or a few related events in one winter season, and are not the product of several smaller, unrelated failures. These few large landslides have accounted for 60-70 percent of debris slide material. Kelsey's study covered a period of 2.5 decades.

Kelsey (1978) did a study of earth flows in the Van Duzen River basin. Within the basin, the 19 active earth-flows covered less than 1 percent of the drainage area but contributed over 10 percent of the sediments moved to the river channel. The earth flow movement and appearance is very similar to alpine glaciers. Kelsey (1978) found evidence that earth-flow movement increased around the 1870s. He attributed this increase to heavy grazing and the change from perennial grasses to annual grasses.

Kelsey (1988) determined that about 60 percent of the sediments in the Redwood Creek channel were derived from hillslope gullying and bank erosion of alluvium and colluvium along low order streams draining the upper hillslopes. This erosion was more evenly distributed throughout the whole basin. Using soil development, B-horizon clay content and redness as a guide, it was determined that the hillslopes around the low order streams were slowly eroding. The slopes adjacent to higher order streams had poor B-horizon development indicating a higher rate of erosion. The low order streams drain a much larger area; as a result they contribute the largest volume of material. The low order streams generally contribute the finer material as they are unable to move the larger cobbles and boulders.

Types of Landslides and Earth Movements Found in the Watershed

Landslides and earth movements can be divided into four basic types: 1) rotational, 2) translational, 3) earth flow, and 4) soil creep. Many of the slides include more than one type of movement. The upper slopes of a

slide will often show different characteristics than the lower slope and toe of the slide where the slide gets broken and churned. The characteristics of the furthest up-slope disturbed area will be used in describing the slide. The stability of a slide is often dependent on what is happening mid-slope and at the toe of the slide. The material piled at the toe of a slide will often support the rest of the slide. Removal of some of the material in the toe, or cutting a trench across mid-slope, will result in the movement of upslope material down to fill in the volume of material removed. A problem also occurs when the toe of the slide is located in a drainage channel where it is washed away, causing more material to continually slide into the channel.

Rotational slides have slip surfaces that penetrate deeply into the bedrock. At the main scarp (highest location of movement), the slip surface is nearly vertical. This slip surface will penetrate down into bedrock where the slip surface slowly turns in a concave fashion so that at the toe of the slide the slope surface is nearly horizontal. At the top of the slide there are one or more large blocks displaced downward with a backward rotation. The top surface will often be tilted so that a small depression will form a holding pond or lake. These slides can be very large, with the distance between the main scarp and the toe over 3-5 miles in some cases, and the slip surface penetrating thousands of feet into the bedrock. The slip surfaces of many of these slides will follow old, previously active faults, bedding, or rock-foliation planes. Movement of these slides can be a very slow creep, or, more commonly, large movements triggered by earthquakes.

The translational slide is a very common style of sliding within the watershed. The slip surface of these slides is usually subparallel to the surface of the ground. The slip surface is located at the contact of firm bedrock and the overlying regolith. These slides will carry large independent blocks of bedrock which were plucked out of the basement along fracture and joint surfaces. The slip surfaces of these slides can be as deep as 200 feet. Deformation and disintegration of the slide mass continues with each successive movement, and runoff from storms enters cracks in the slide surface. These slides usually move in the winter, and are stable during the summer. The slides move down-slope until they reach a channel where streamflow can wash the toe away. Rate of slide movement is strongly dependent on land-use and watershed conditions.

Earth-flow slides consist of unconsolidated materials that move as a plastic or viscous fluid when saturated. Movement is over a discrete surface, usually a resistant lower soil profile. These earth-flows are most common on soils containing a high percentage of clays, which become saturated in winter. Earth-flows can deliver a large volume of sediment in a very short time to a stream channel. The size and number of earth-flows and the volume of sediment produced is strongly dependent on land use and the health of the vegetation cover. Most earth-flows occurs within the rooting depth of many common plants.

Soil creep is a common geomorphic process occurring in soils subject to freeze-thaw cycles, and soils containing expansive clays. When a soil freezes, or expansive clays get wet, they will expand and lift perpendicular to slope. But when thawing or drying of the soil occurs the soil drops vertically due to gravity. As a result, the whole soil mantle slowly creeps downslope a small amount with each expansion and contraction cycle. Since the total area of the landscape situated on a slope is very large, the total volume of sediments moving into a drainage is also very large. Land use activities and vegetation cover can influence the rate of creep.

Landsliding and Sediment Problems Associated With Recreation Developments

Summer recreation within the forest is often associated with ponds and lakes. Developing additional ponds and lakes to increase summer use provides an economic benefit to the local community. However, most ponds and lakes within the watershed are caused by slide movement. Increasing recreational opportunities by diverting water into ponds and depressions, or by increasing the depth of a pond, would improve recreational opportunities, but will increase the potential for slide movement.

Landsliding and Sediment Problems Associated With Timber Harvest

Deeply rooted trees and shrubs provide cohesive strength against slides, and help remove water through evapotranspiration. Keeping the landscape stocked with trees and shrubs reduces sliding potential and decreases erosion. Large trees, with their deep roots, do the most to stabilize soil and slides. These large trees are resistant to low intensity (less than 4-foot flame height) ground fires, but a high intensity fire can kill even large trees and other vegetation holding the soil and regolith (see Section 6.5).

16.6 Recreation

Table 16.6-1. CURRENT FOREST SERVICE FACILITIES AT LAKE PILLSBURY

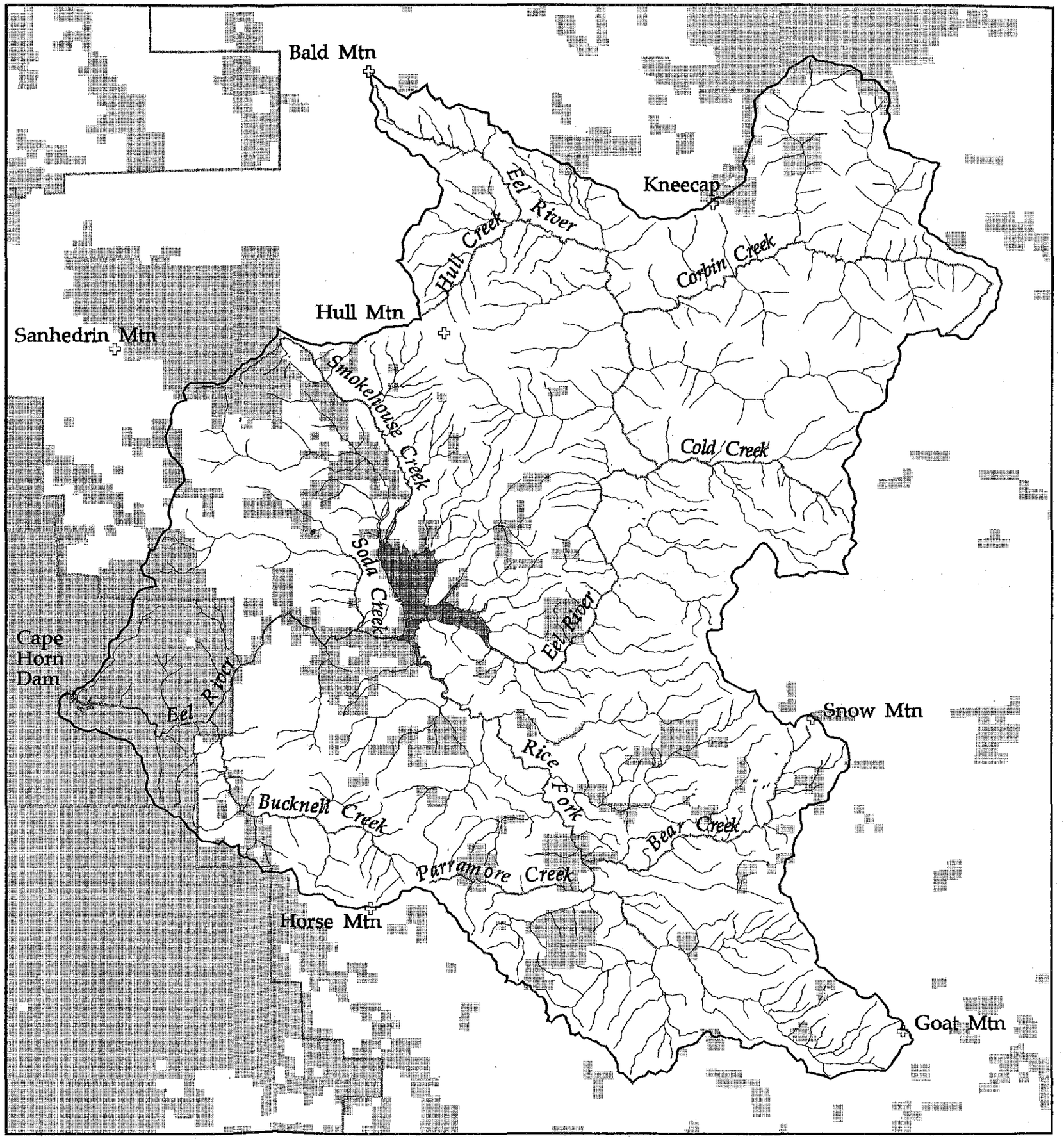
Area Name	Home/Camping Units	Day-use Sites	Boat Space	Dates
Pogie Point Campground	42	3		1940s 1983-84
Pogie Point Day-use		6		1940s
USFS Summer Home Tract	71			1941-60
Sunset Campground				1964
Fuller Grove Boat Ramp			39	1986-87
Fuller Grove Campground	29			1986-87
Fuller Grove Day-Use		2		1986-87
Pillsbury Pines Boat Ramp			22	1986-87
Pillsbury Pines Day-Use		7		1986-87
Fuller Grove Group Camp	12			1993-94
Navy Camp	22			1993-94
Oak Flat	≥100 people[1]			
Squaw Creek Campground	5			
Totals	252	15	61	

[1]Campground used by up to/more than 100 people on Memorial, Independence, and/or Labor Day holidays

16.7 Plates

PLATE 1

Hydrography



Lakes and reservoirs
Intermittent and perennial streams
Watershed boundary
Mendocino Forest boundary
Federal ownership
Private land

SCALE 1:180000

1 0 1 2 3 4

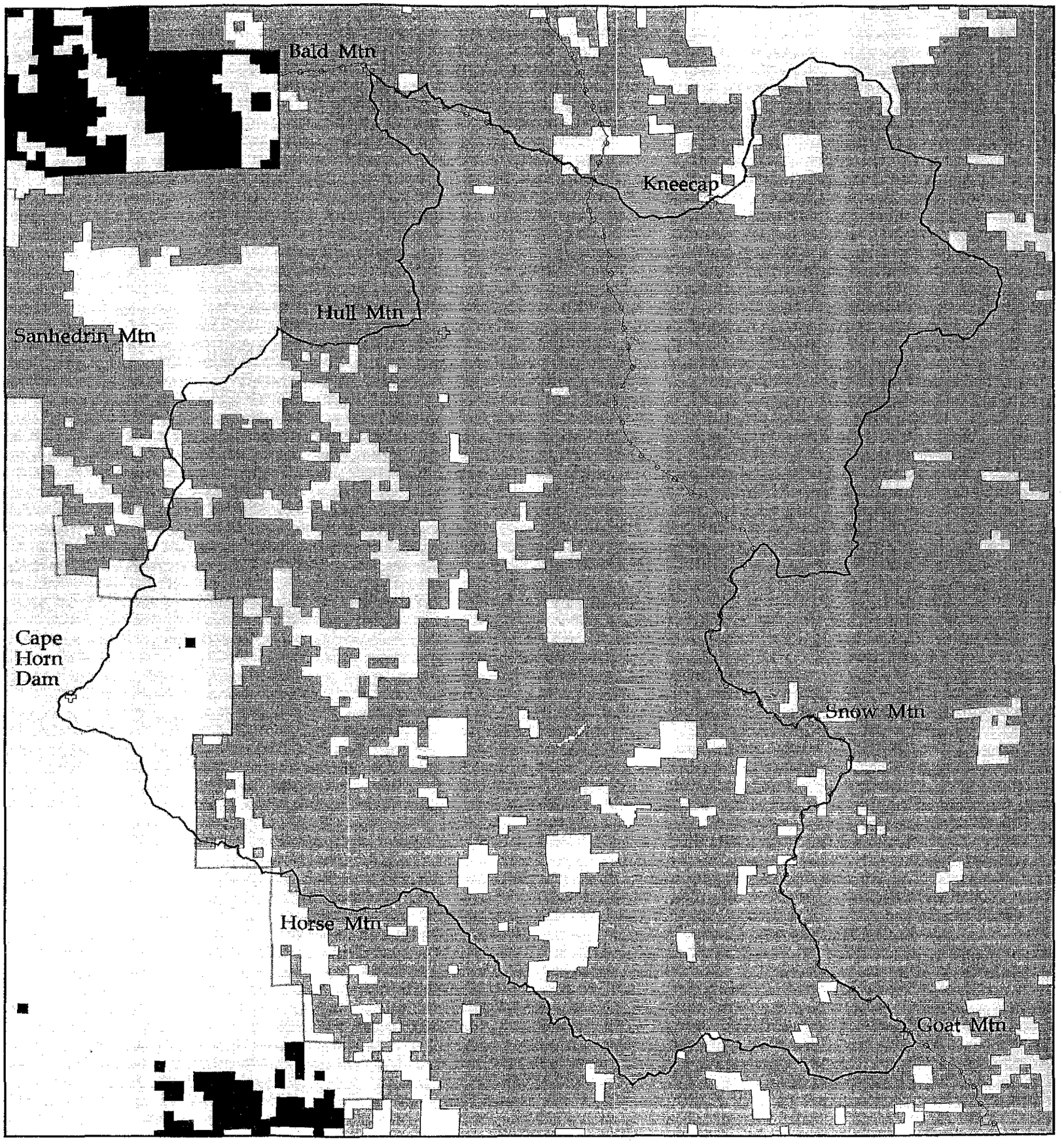
MILES

N

Source: USGS Cartographic Feature Files.

PLATE 2

Ownership and Administration



National Forest land
Bureau of Land Management
Private/State land
Ranger District boundary
Watershed boundary
Mendocino Forest boundary

SCALE 1:180000

1 0 1 2 3 4

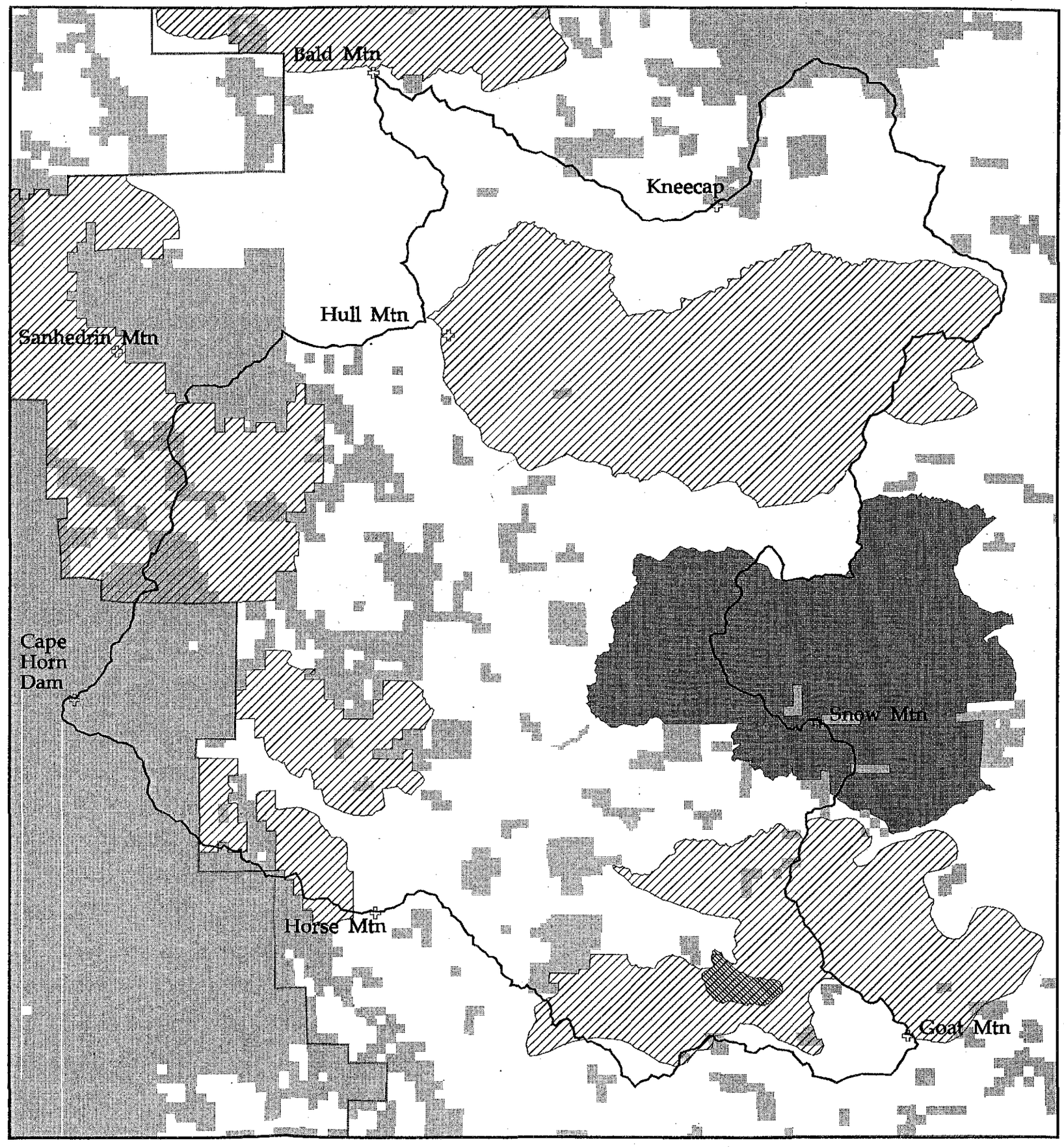
MILES

N

Source: BLM 1:100,000 quad maps, Mendocino National Forest, USGS Base Series Maps.

PLATE 3

Land Allocation



Late Successional Reserves
Snow Mountain Wilderness
Research Natural Area
Watershed boundary
Mendocino Forest boundary
Federal ownership
Private land

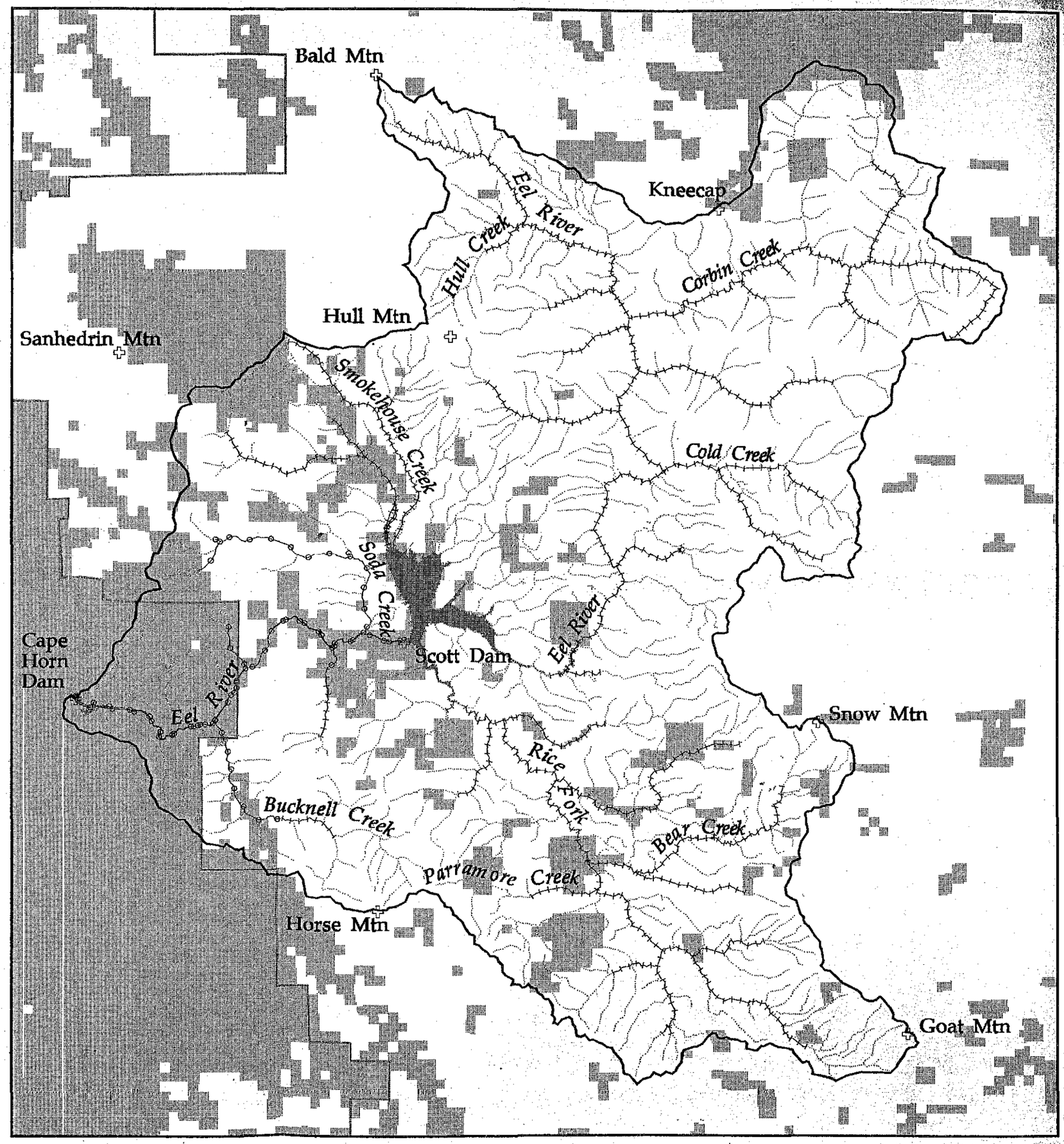
SCALE 1:180000
1 0 1 2 3 4
MILES

N

Source: Mendocino National Forest, USGS Base Series Maps, FEIS, 1994.

PLATE 4

Fish-Bearing Streams



Lakes and reservoirs
Anadromous fish present
Resident fish present
Other non-fish bearing streams
Watershed boundary
Mendocino Forest boundary
Federal ownership
Private land

SCALE 1:180000

1 0 1 2 3 4

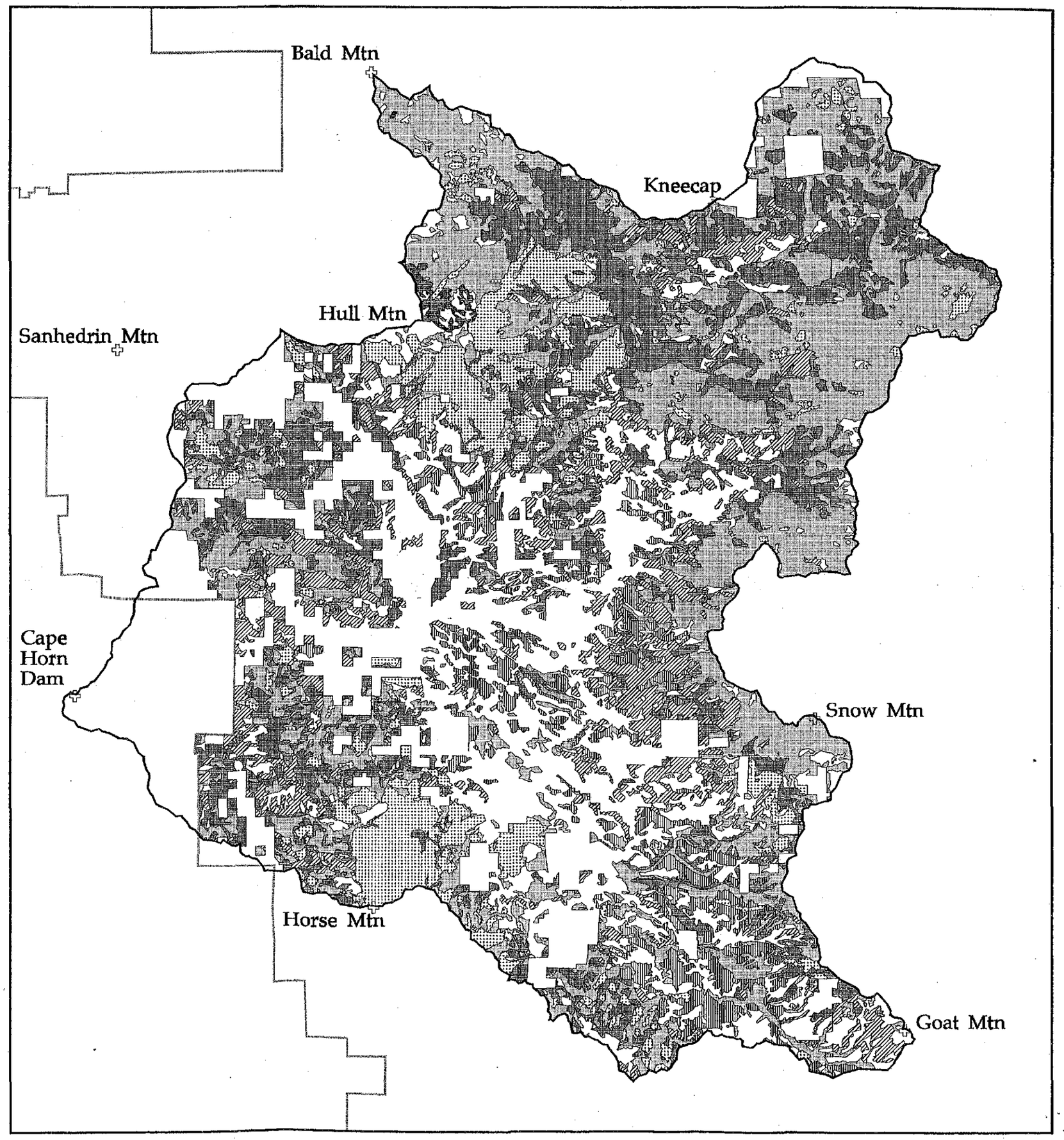
MILES

N

Source: Mendocino National Forest, USGS Cartogrpahic Feature Files.

PLATE 5

Forest Vegetation Distribution



- Conifer-Hardwoods
- Hardwoods
- Knobcone Pine
- Mixed Conifer
- Red Fir
- Plantations
- Watershed boundary
- Mendocino Forest boundary

Note: Veg. data unavailable in private areas.

SCALE 1:180000

1 0 1 2 3 4

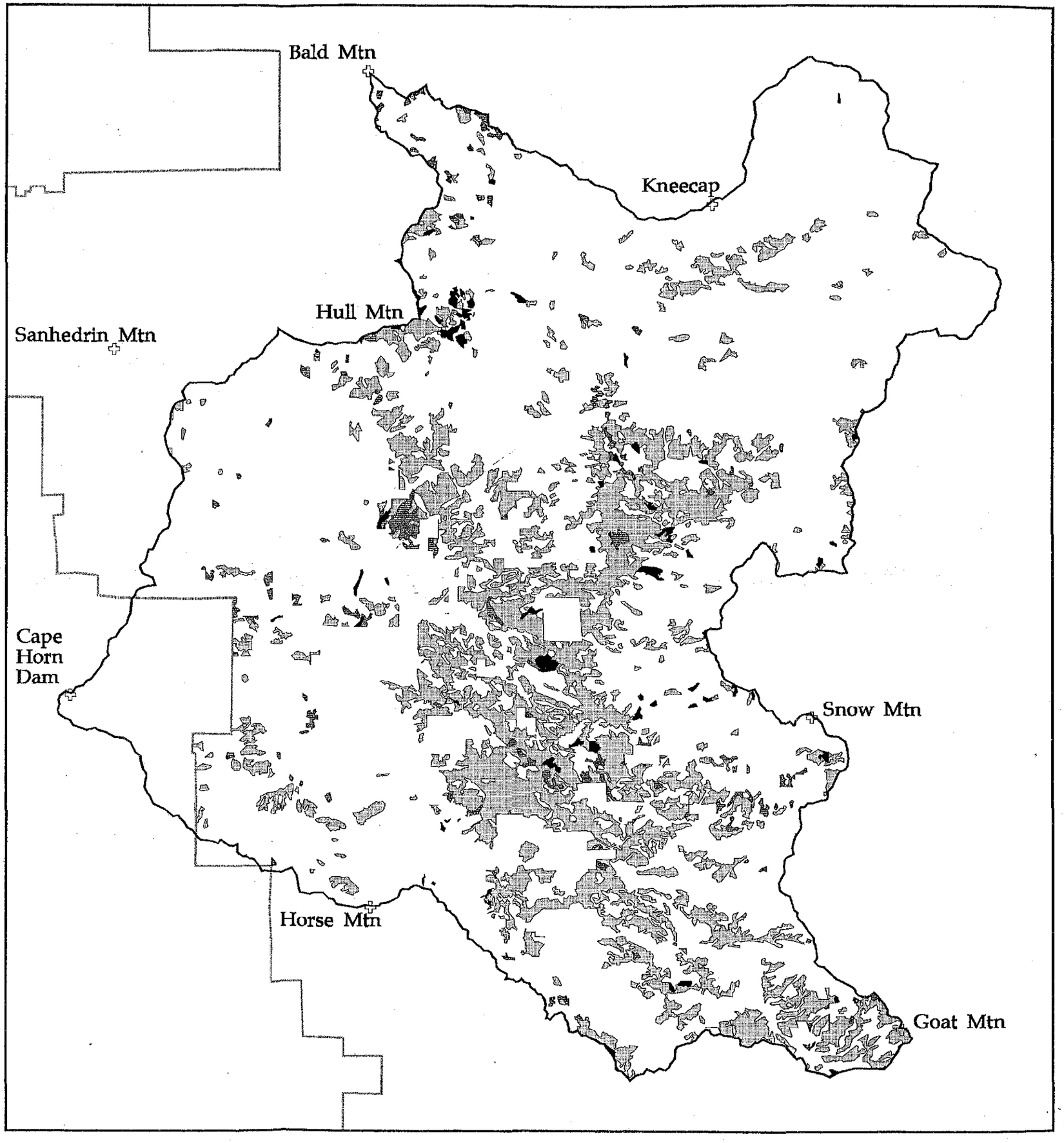
MILES

N

Source: Mendocino National Forest

PLATE 6

Non-Forest Vegetation Distribution



Barren

Grasses

Shrub types

Watershed boundary

Mendocino Forest boundary

Note: Veg. data unavailable in private areas.

SCALE 1:180000

1 0 1 2 3 4

MILES

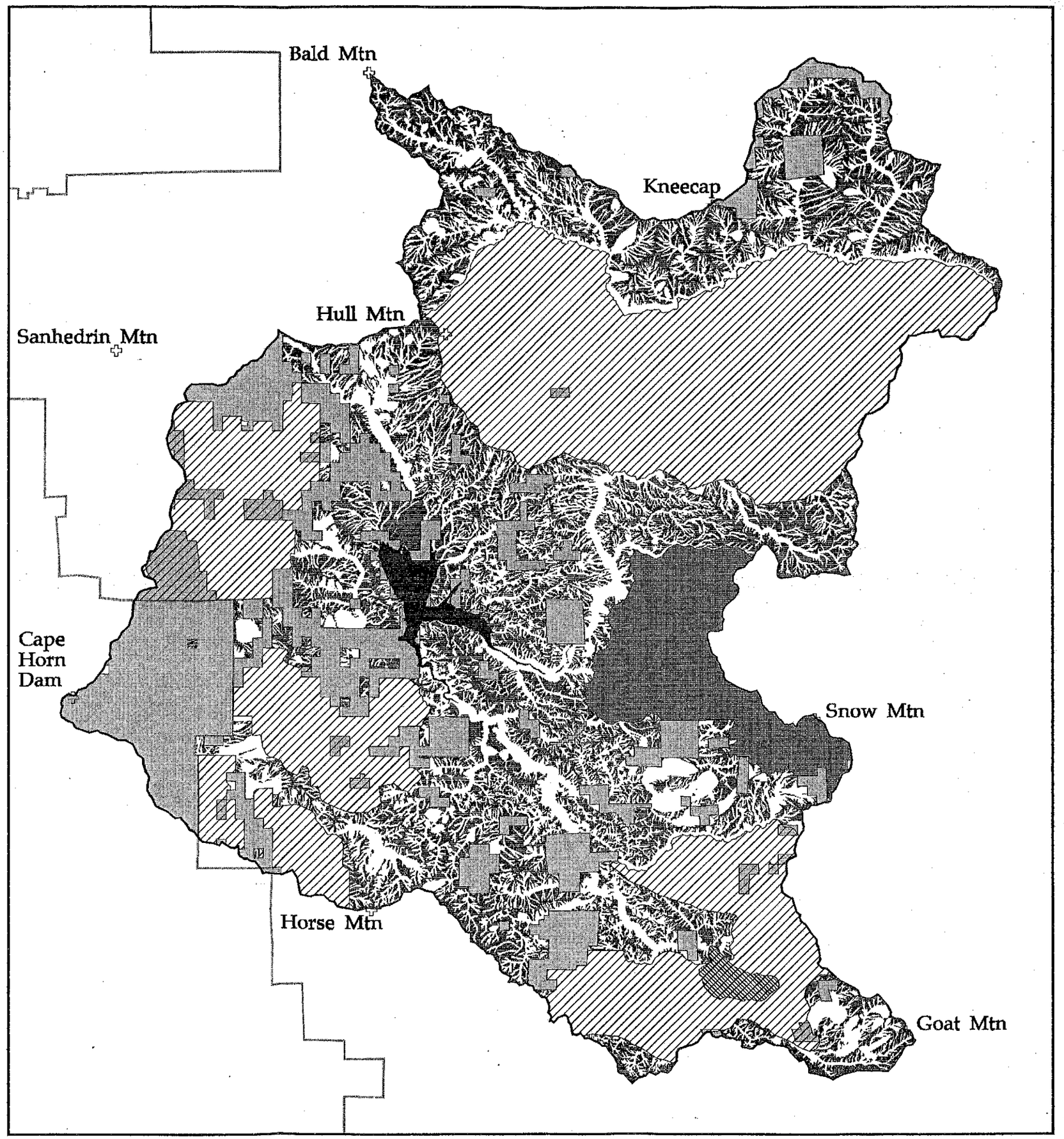
N

Source: Mendocino National Forest

PLATE 7

Interim Riparian Reserves

- Interim Riparian Reserve area
- Matrix area
- Late Successional Reserves
- Snow Mountain Wilderness
- Research Natural Area
- Private land
- Lakes and Reservoirs
- Watershed boundary
- Mendocino Forest boundary



SCALE 1:180000

1 0 1 2 3 4

MILES

N

Source: USGS Cartographic Feature Files, Mendocino National Forest, and Record of Decision, 1994.